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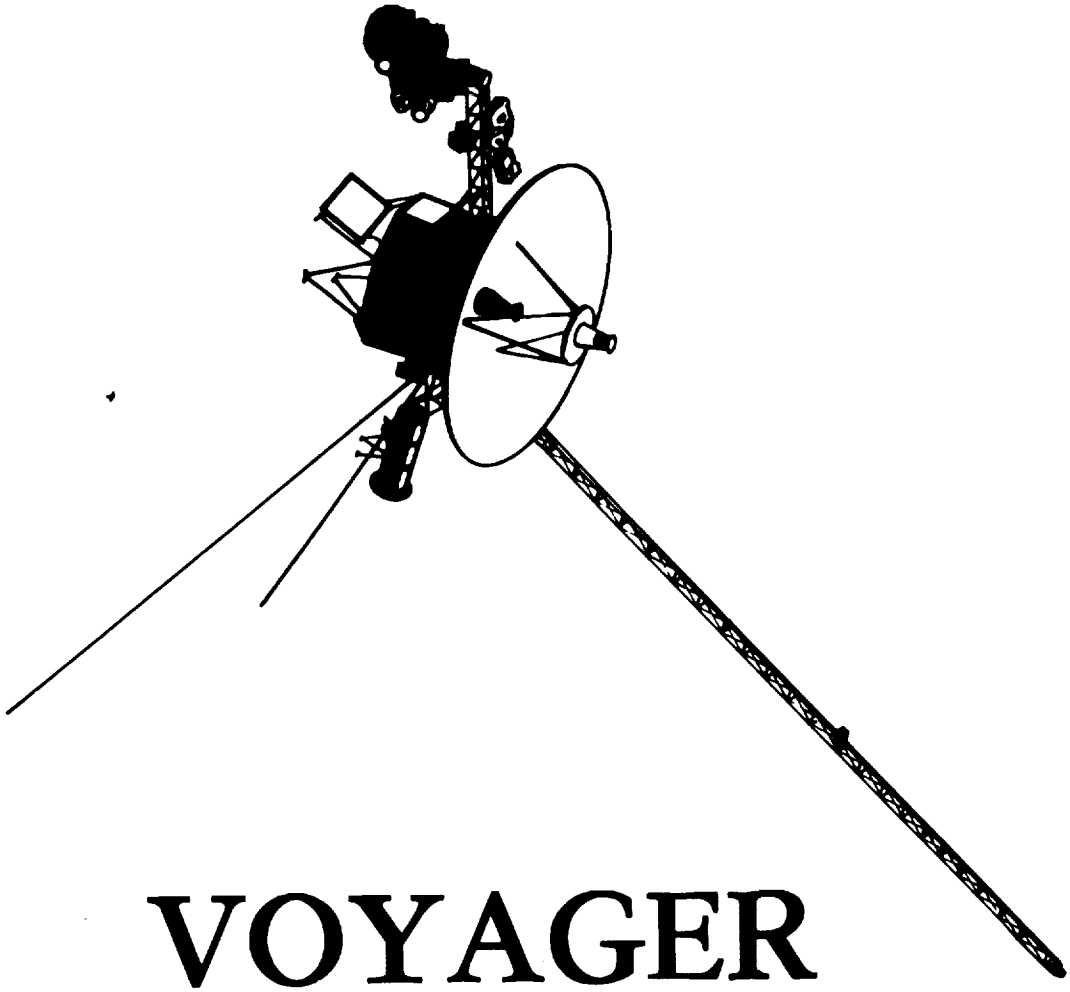

VOYAGER
TO JUPITER

(NASA-CR-197881) VOYAGER TO JUPITER, VOLUME 3 (JPL) 82 p

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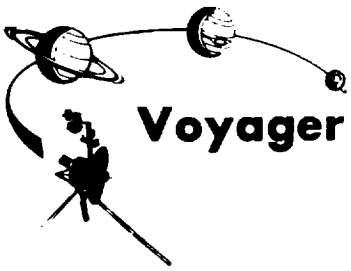
NASA
National Aeronautics and Space Administration

TABLE OF CONTENTS



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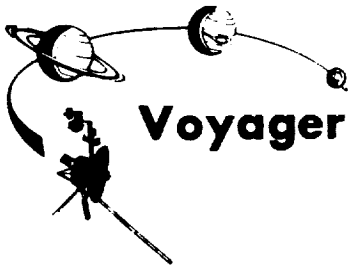

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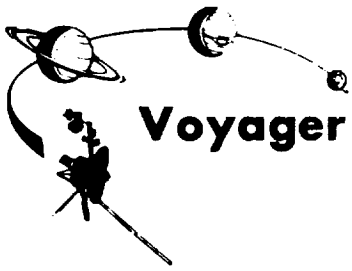
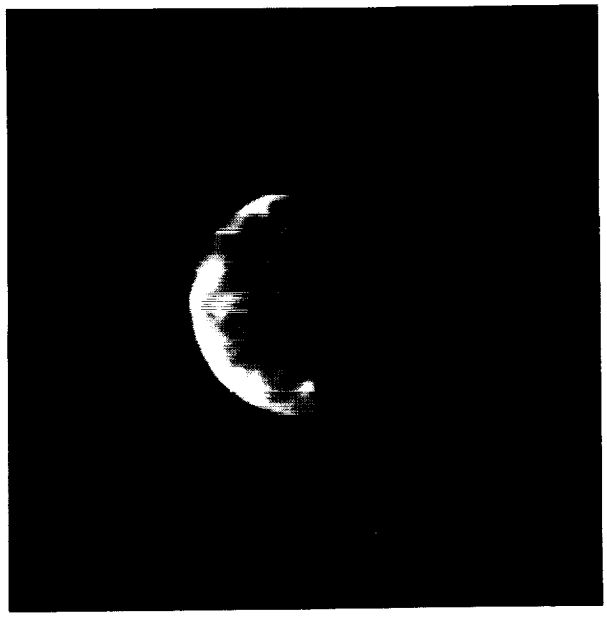
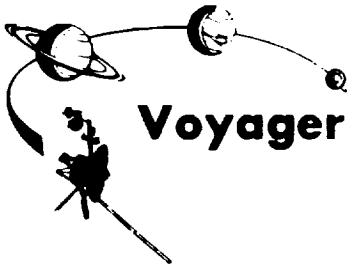


JPL # P-21149 C

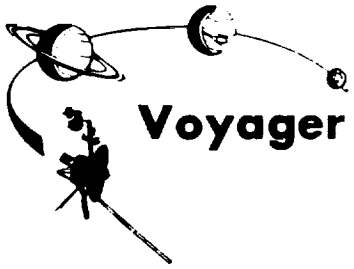
This photo of Callisto, outermost of Jupiter's four Galilean satellites, was taken a few minutes after midnight (PST) on February 26 by Voyager 1. The distance to Callisto was 8,023,000 kilometers (4,980,000 miles). The hemisphere in this picture shows a fairly uniform surface dotted with brighter spots that are up to several hundred kilometers across. Scientists believe the spots may be impact craters, but higher-resolution photos will be necessary before the features can be interpreted. Callisto is about the same size as the planet Mercury—about 5,000 kilometers (3,000 miles) in diameter. Callisto is much less massive than Mercury, however, with a density less than twice that of water. Therefore, scientists believe that Callisto is composed of a mixture of rock and ice (up to about 50 percent by weight). Its surface is darker than those of the other Galilean satellites, but is still about twice as bright as Earth's Moon. This color photo was assembled from three black-and-white images in the Image Processing Lab at Jet Propulsion Laboratory. JPL manages and controls the Voyager project for NASA's Office of Space Science.





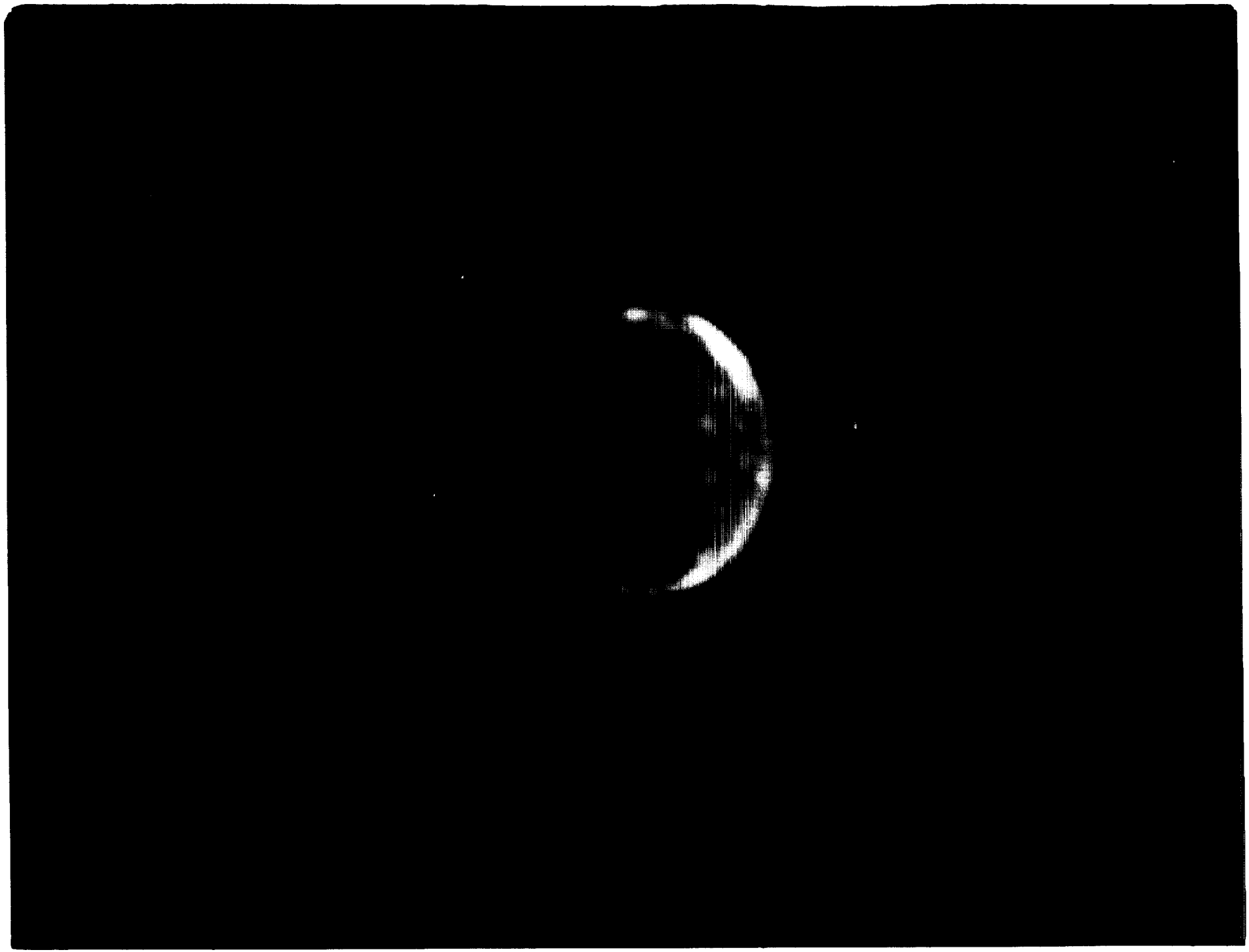
HQ # 79-H-93

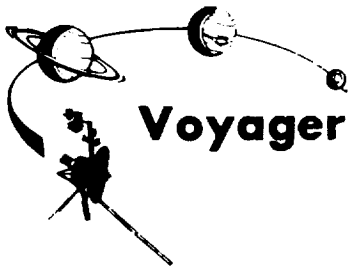
Voyager 1 took this picture of Europa, Jupiter's second Galilean satellite, early on the morning of March 1, 1979, from a distance of 5.9 million kilometers (3.66 million miles). The photo was taken through a violet filter and shows faint swirls and linear patterns in Europa's equatorial region. The hemisphere shown here is that which always faces Jupiter. North is to the right. The equatorial region is slightly darker than the poles. Although Europa is the brightest of the Galilean satellites, it exhibits low contrast on this hemisphere. Like Io, Europa has a density and size comparable to Earth's Moon. But unlike Io, which is apparently dry, Europa shows Earth-bound observers many indications of water ice or ground water on its surface.



HQ # 79-H-94

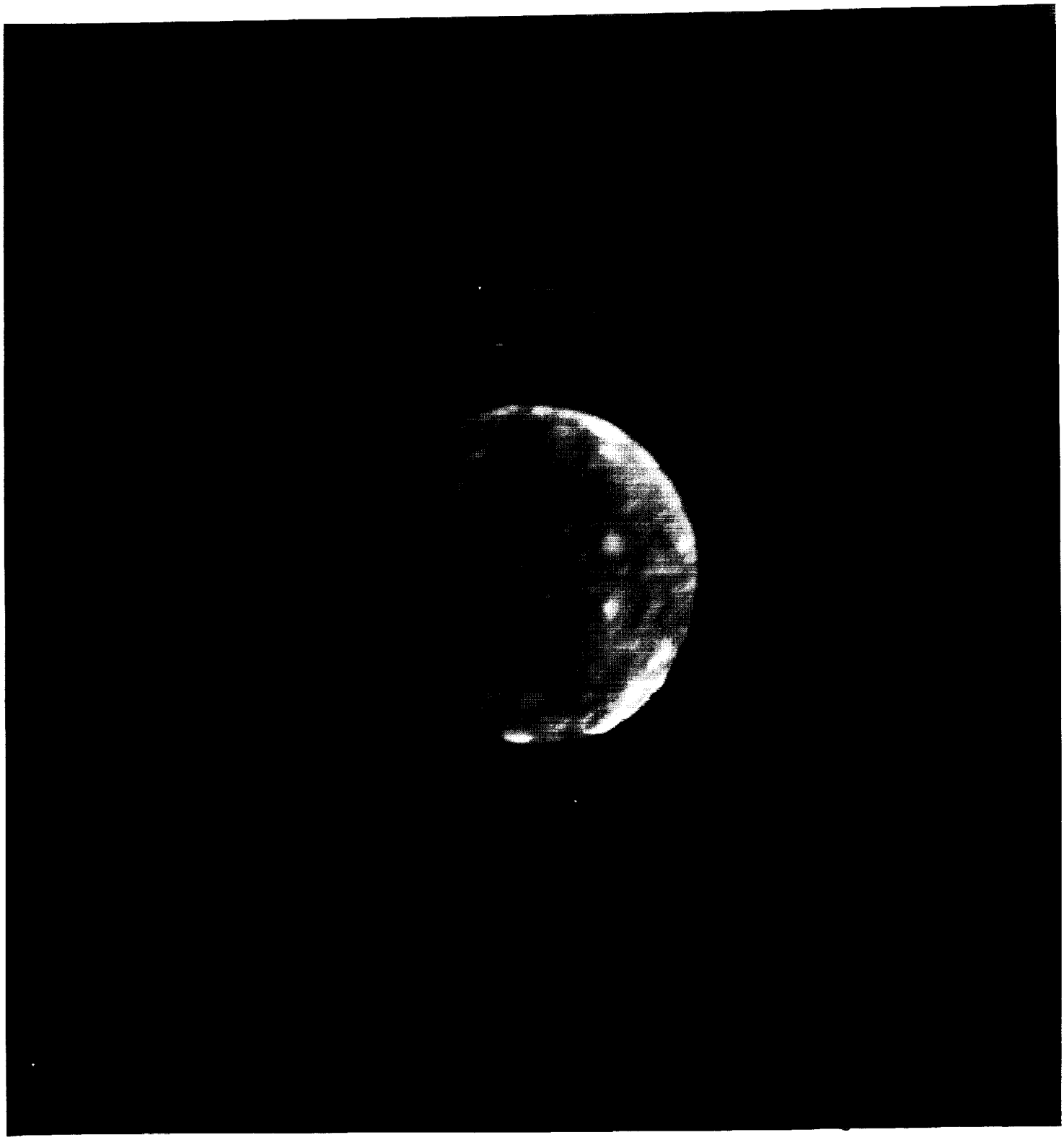
This Voyager 1 picture of the outermost Galilean satellite, Callisto, was taken February 28 through a violet filter from a distance of about 8 million kilometers (5 million miles). Callisto is the darkest of the four Galilean satellites of Jupiter, but is still nearly twice as bright as Earth's Moon. It shows a mottled appearance consisting of bright and dark patches. The bright spots remind scientists of rayed or bright haloed craters, similar to those seen on our Moon. This face of Callisto is always turned toward Jupiter.

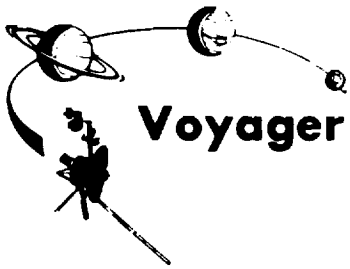




HQ # 79-HC-79
79-H-104

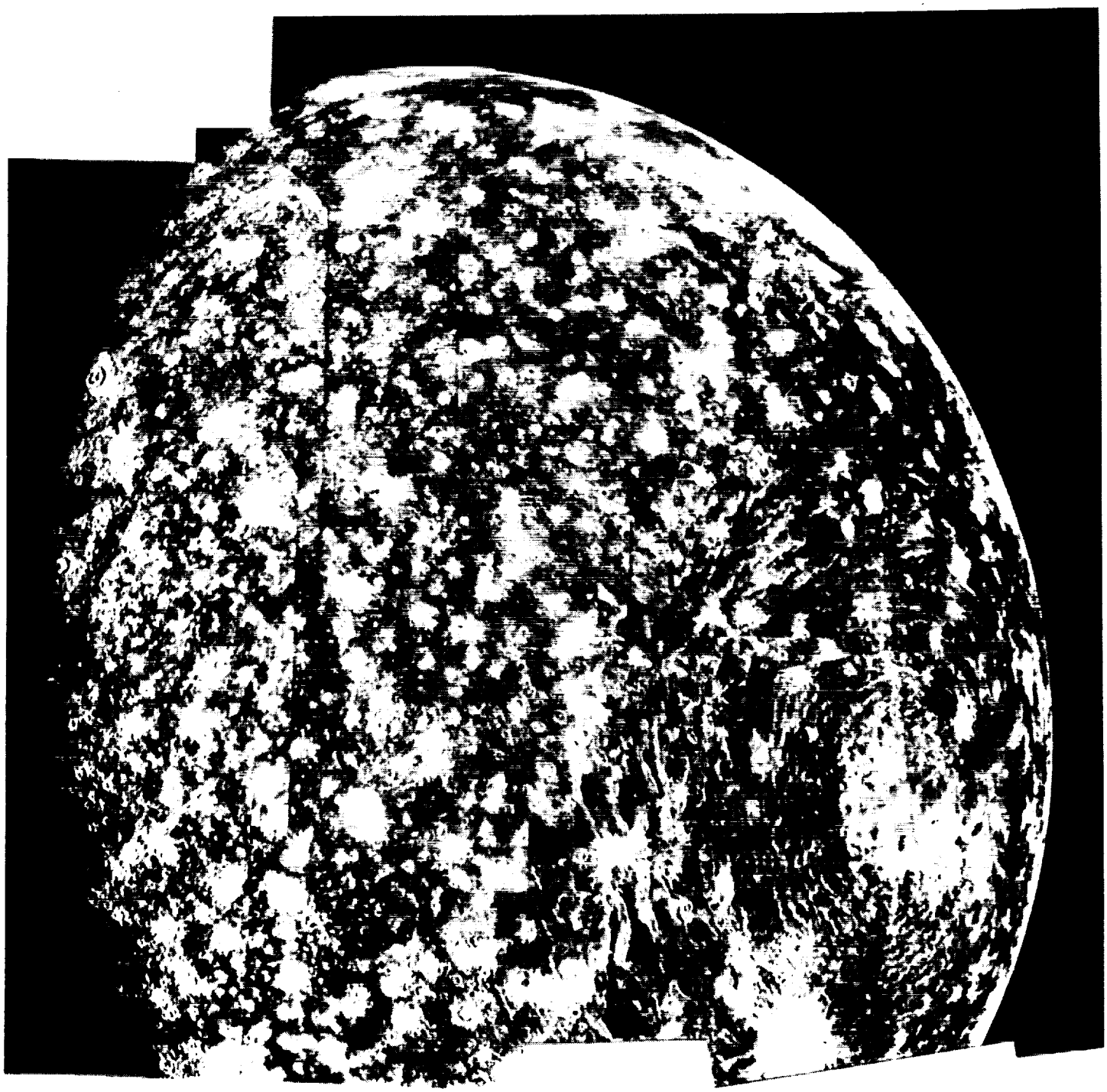
This Voyager 1 picture of Callisto, the outermost Galilean satellite, was taken February 28 from a distance of about 8 million kilometers (5 million miles). Callisto is the darkest of the Galilean satellites, but is still nearly twice as bright as the Earth's Moon. The surface shows a mottled appearance consisting of bright and dark patches. The bright spots remind scientists of rayed or bright haloed craters, similar to those seen on the Earth's Moon. The Galilean satellites all show the same face on Jupiter—just as the Earth's Moon always shows us the same face. In this photo we see the face of Callisto that always faces Jupiter.

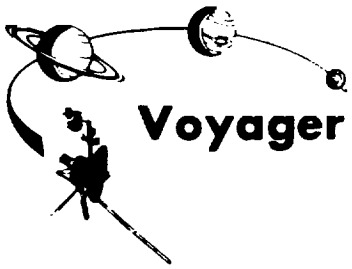




HQ # 79-H-131

This photomosaic of Callisto was assembled from pictures taken by Voyager 1 on the morning of March 6, 1979, from a range of 202,000 kilometers (121,000 miles). Callisto is the darkest and most distant of the Galilean satellites of Jupiter. Its surface has been heavily cratered by meteorite impacts, and is probably the oldest surface of any Galilean satellite. Many of the craters display bright ray systems similar to those on our Moon. The large bright spot near Callisto's limb, in the upper left corner of the picture, is an impact basin about 600 kilometers (360 miles) in diameter. Numerous concentric rings surrounding the basin probably result from the response of an icy crest to shock waves produced by the large impact. These rings extend outward from the basin to distances of more than 1,000 kilometers (600 miles).

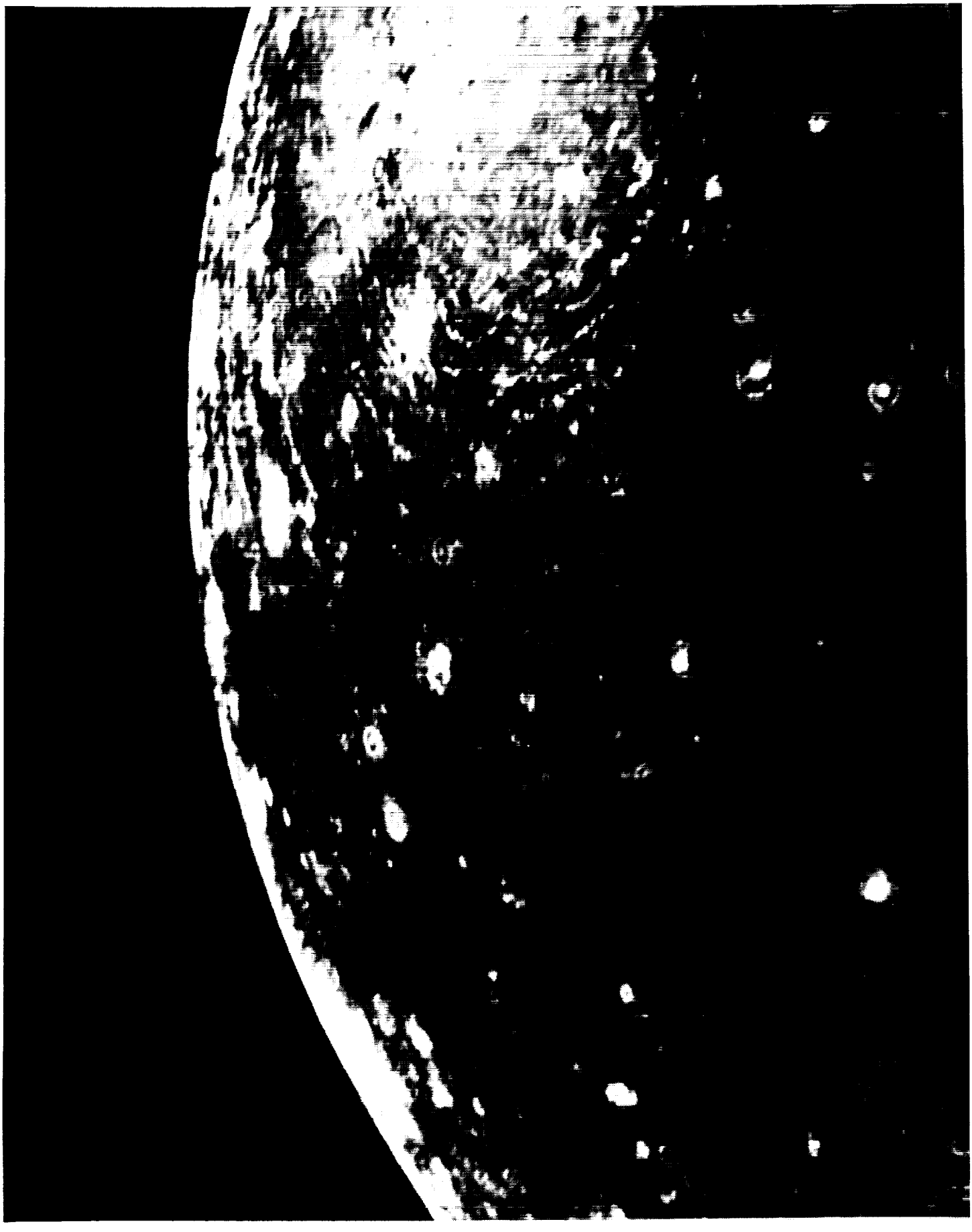


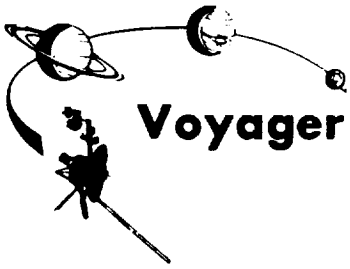


HQ # 79-H-133
79-HC-104

This picture of Callisto was taken by Voyager 1 on Tuesday, March 6, during its approach to Jupiter's outer large satellite. The spacecraft was 350,000 kilometers (220,000 miles) from Callisto at the time, and shows features about 7 kilometers (4 miles) across on the surface. Callisto is a little smaller than Ganymede (about the size of the planet Mercury), and is apparently composed of a mixture of ice and rock. The dark color of Callisto (about half as reflective as Ganymede but still twice as bright as the Moon) suggests that its upper surface is "dirty ice" or water-rich rock frozen at Callisto's cold surface (approximately 120° K, or -243° F, at the equator). Callisto shows far more craters on its surface than does Ganymede, leading scientists to believe that its surface is the oldest observed so far in the Galilean system, possibly dating back to final accretional stages of planet formation 4-4.5 billion years ago.

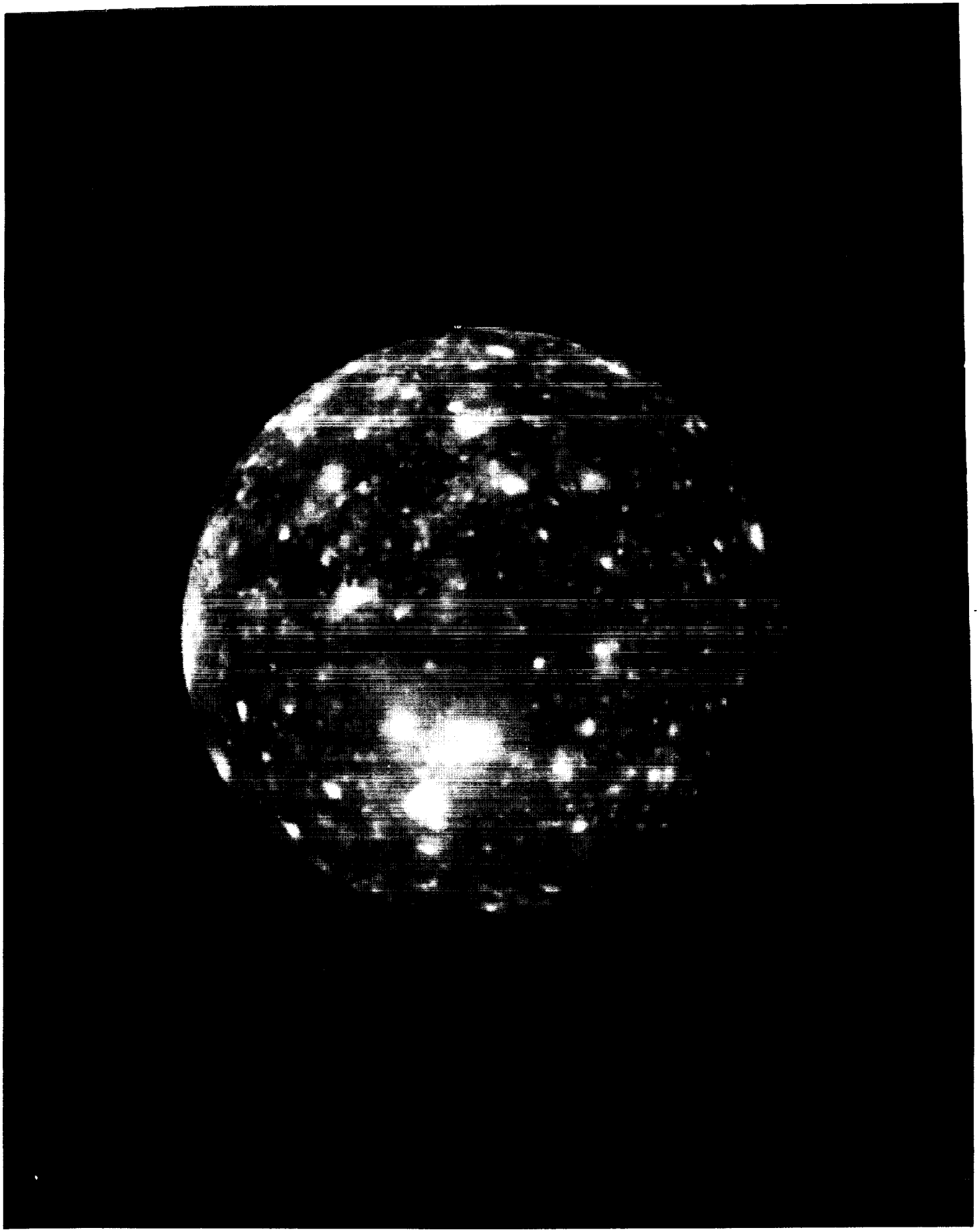
The prominent bull's-eye type feature in this picture is believed to be a large impact basin, similar to Mare Orientale on the Moon and the Caloris Basin on Mercury. The brighter circular spot is about 600 kilometers (400 miles) across. The outer ring is about 2,600 kilometers (1,600 miles) across. This is the first recognized basin in the Jovian system, and it supports the concept of an old surface for Callisto. The lack of relief (high ridges, ring mountains, or a large central depression) suggests that the impacting body may have come close to penetrating Callisto's crust. The differences in the appearance of this basin compared with those of the inner solar system may result from fracturing of Callisto's crust. The lack of obvious basins on the side of Ganymede, as observed by Voyager 1, and the smaller number of craters on Ganymede's surface suggest to scientists that Callisto may have a thicker crust than Ganymede.

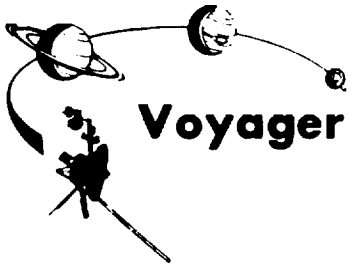




HQ # 79-HC-269
79-H-373

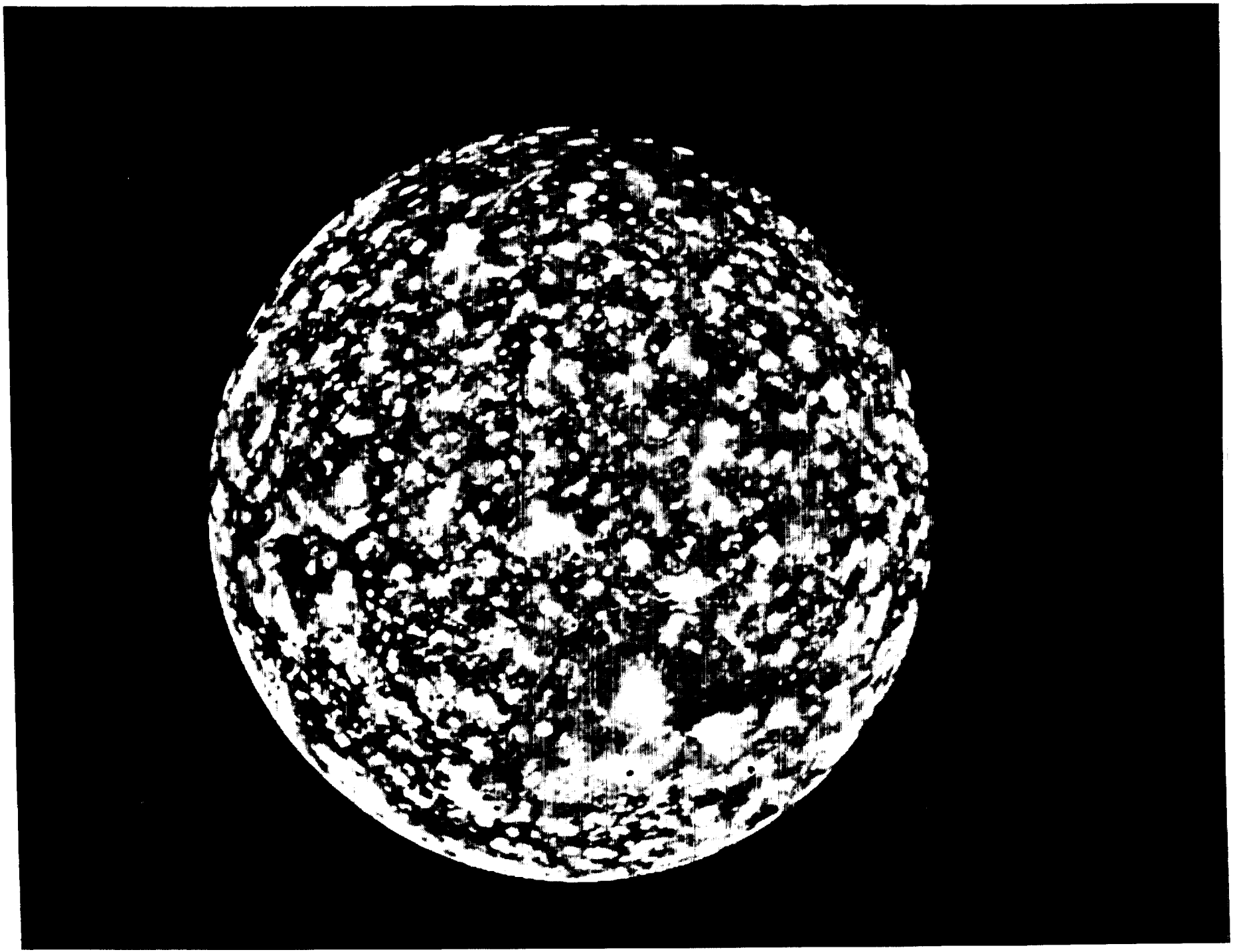
This picture of Callisto was taken by Voyager 2 on July 7 from a distance of 2,318,000 kilometers (1,438,000 miles). Callisto is covered with bright spots which are meteorite impact craters—a fact originally discovered from the high-resolution pictures taken by Voyager 1 last March. Scientists believe that heavily cratered terrains like those on Callisto are indicative of ancient planetary surfaces. Voyager 2 will fly by the lower left part of the satellite and map the side not seen by Voyager 1. The obscure dark streaks in this area may be fault zones; higher-resolution pictures in the next two days will allow them to be identified.

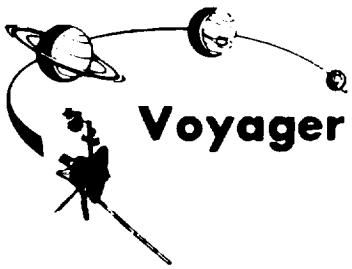




HQ # 79-H-377

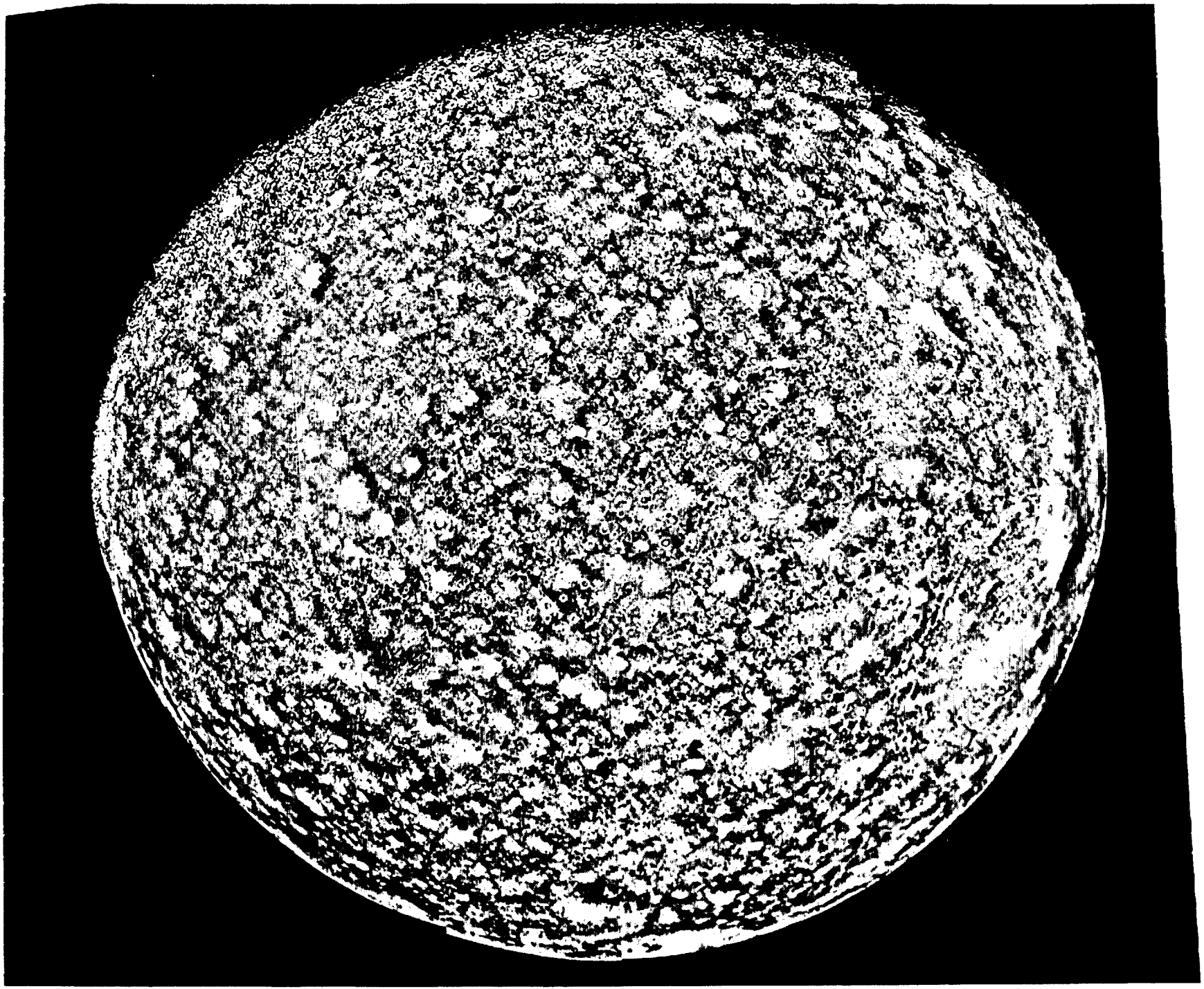
This black-and-white image of Callisto was taken by Voyager 2 about 3:20 a.m. PDT Saturday, July 7, from a range of about 1.1 million kilometers (675,000 miles). Top of photo is at left. The picture has been enhanced to reveal detail in the scene. Voyager 1's high-resolution coverage was of the hemisphere just over the right-hand (eastern) horizon, and the large ring structure discovered by Voyager 1 is just over the eastern limb. This image shows yet another ring structure in the upper part of the picture. Callisto exhibits some of the most ancient terrain seen on any of the satellites. Scientists think Callisto's surface is a mixture of ice and rock dating back to the final stages of planetary accretion (over 4 billion years ago) when the surface was pock-marked by a torrential bombardment of meteorites. Younger craters show as bright spots, probably because they expose fresh ice and frost.

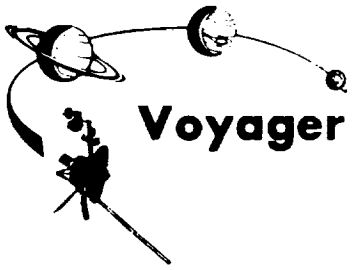




HQ # 79-H-378

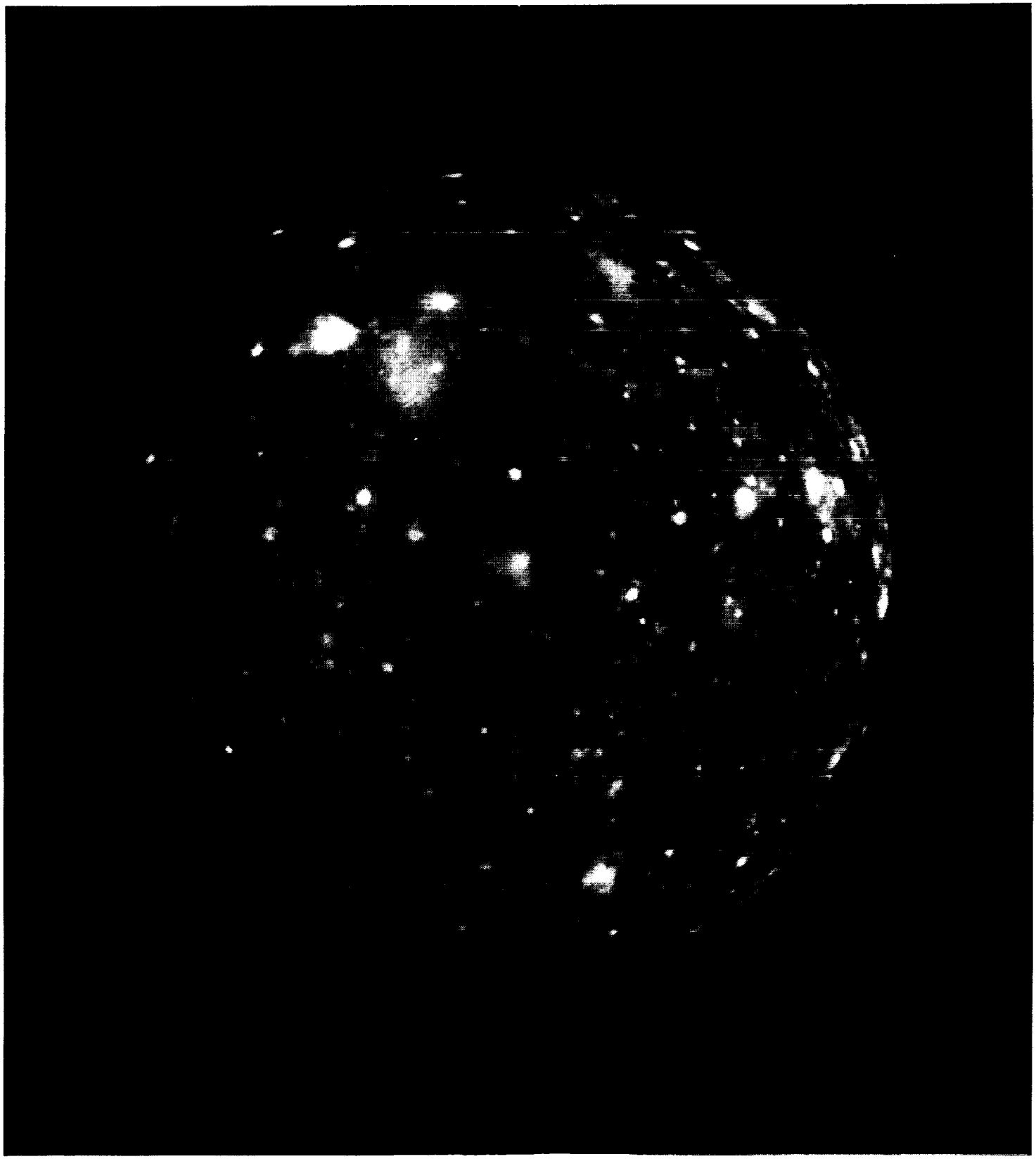
This photomosaic of Callisto, taken Saturday night at 10:00 p.m. at a range of 390,000 kilometers (245,000 miles), is composed of nine frames. The impact crater distribution is quite uniform across the disk. Notable are the very bright rayed craters, which probably are very young. Near the limb is a giant probable impact structure. Several large structures were discovered by Voyager 1. This one is smaller than the largest one found by Voyager 1, but is more clearly shown. About 15 concentric rings surround the bright central spot. Many hundreds of moderate mixed impacts are also seen, a few with bright radial ray patterns. The limb is very smooth, confirming that no high topography has been seen on the satellite—an observation consistent with its icy composition.

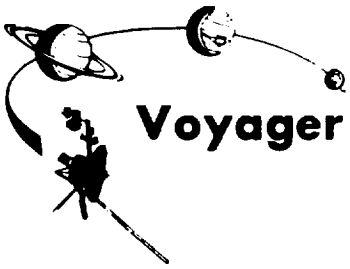




HQ # 79-HC-274
79-H-380

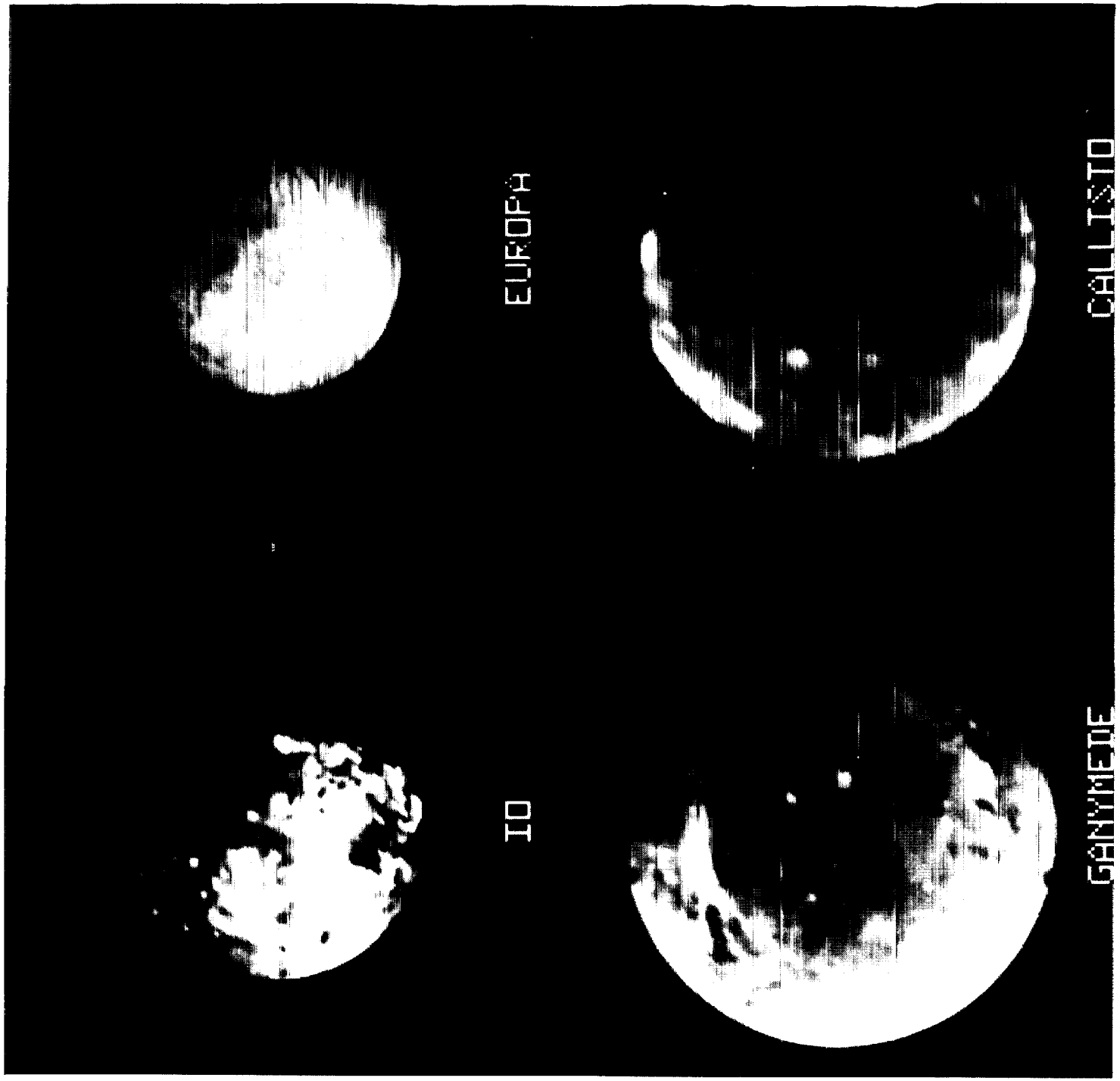
This false-color picture of Callisto was taken by Voyager 2 on July 7, 1979, at a range of 1,094,666 kilometers (677,000 miles), and is centered on 11 degrees N and 171 degrees W. This rendition uses an ultraviolet image for the blue component. Because the surface displays regional contrast in UV, variations in surface materials are apparent. Notice in particular the dark blue halos which surround bright craters in the eastern hemisphere. The surface of Callisto is the most heavily cratered of the Galilean satellites and resembles ancient, heavily cratered terrains on the Moon, Mercury, and Mars. The bright areas are ejecta thrown out by relatively young impact craters. A large ringed structure, probably an impact basin, is shown in the upper left part of the picture. The color version of this picture was constructed by compositing black-and-white images taken through ultraviolet, clear, and orange filters.

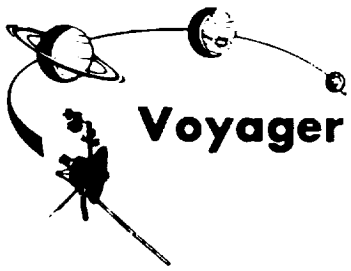




HQ # 79-H-108

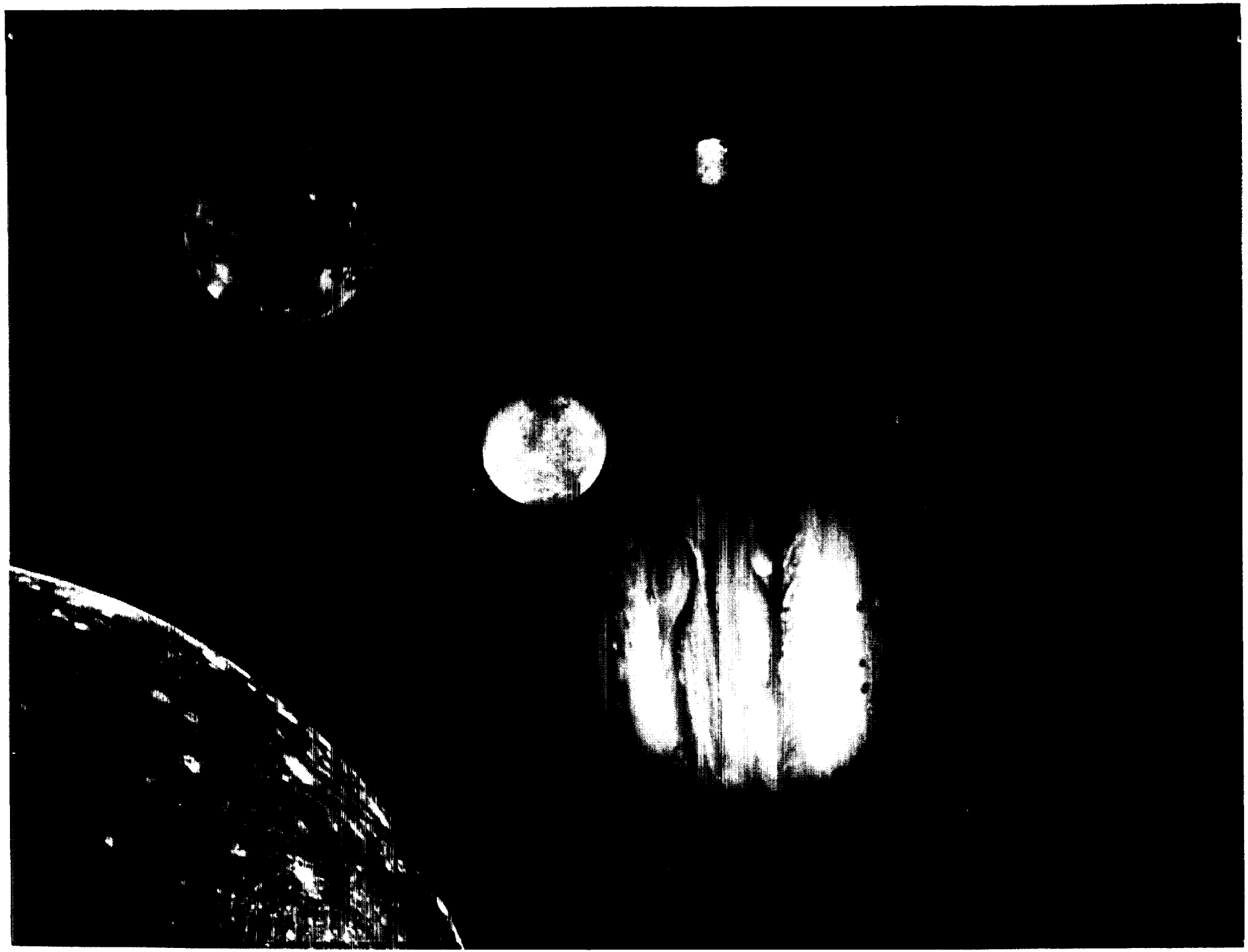
These photos of the four large Galilean satellites of Jupiter were taken with violet filters by Voyager 1 between March 1 and 3, 1979. North on each photo is at bottom. In this picture they are shown at their correct relative sizes: the two biggest, Ganymede and Callisto, are larger than the planet Mercury, while Io and Europa are about the size of our Moon. The photographic processing preserves relative contrast on the satellites; thus it is apparent that Europa has the least contrast and Io the greatest. It has not been possible, however, to illustrate the true relative brightness of these satellites. Their reflectivenesses in visible light are: Europa, 46%; Io, 36%; Ganymede, 43%; and Callisto, 17%. Dark as it is, however, Callisto is more reflective than our Moon (12%). The two brightest satellites, Io and Europa, apparently have surfaces of very different composition. Io is thought to be covered with sulfur and salts, and Europa with water ice. Ganymede has both ice and rock exposed on its surface, while Callisto is primarily rocky. These surface properties contrast sharply with the interiors of the satellites: Io and Europa have rocky interiors, while Ganymede and Callisto contain large amounts of water or ice. The smallest markings on these images are about 50 kilometers (30 miles) across, except for Callisto, which has a resolution of 100 kilometers (60 miles). Specific data on range and central longitudes for the four images are: Io, 2.9 million kilometers (1.7 million miles), 236 degrees; Europa, 2.9 million kilometers (1.7 million miles), 150 degrees; Ganymede, 3.4 million kilometers (2.0 million miles), 252 degrees; Callisto, 6.9 million kilometers (4.1 million miles), 317 degrees. JPL manages and controls the Voyager Project for NASA's Office of Space Science.

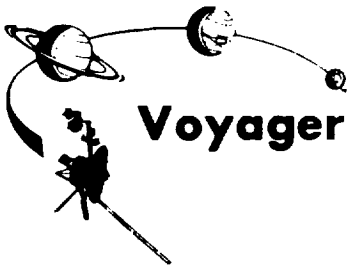

EUROPA
CALLISTO
IO
GANYMEDE



HQ # 79-H-356
79-HC-256

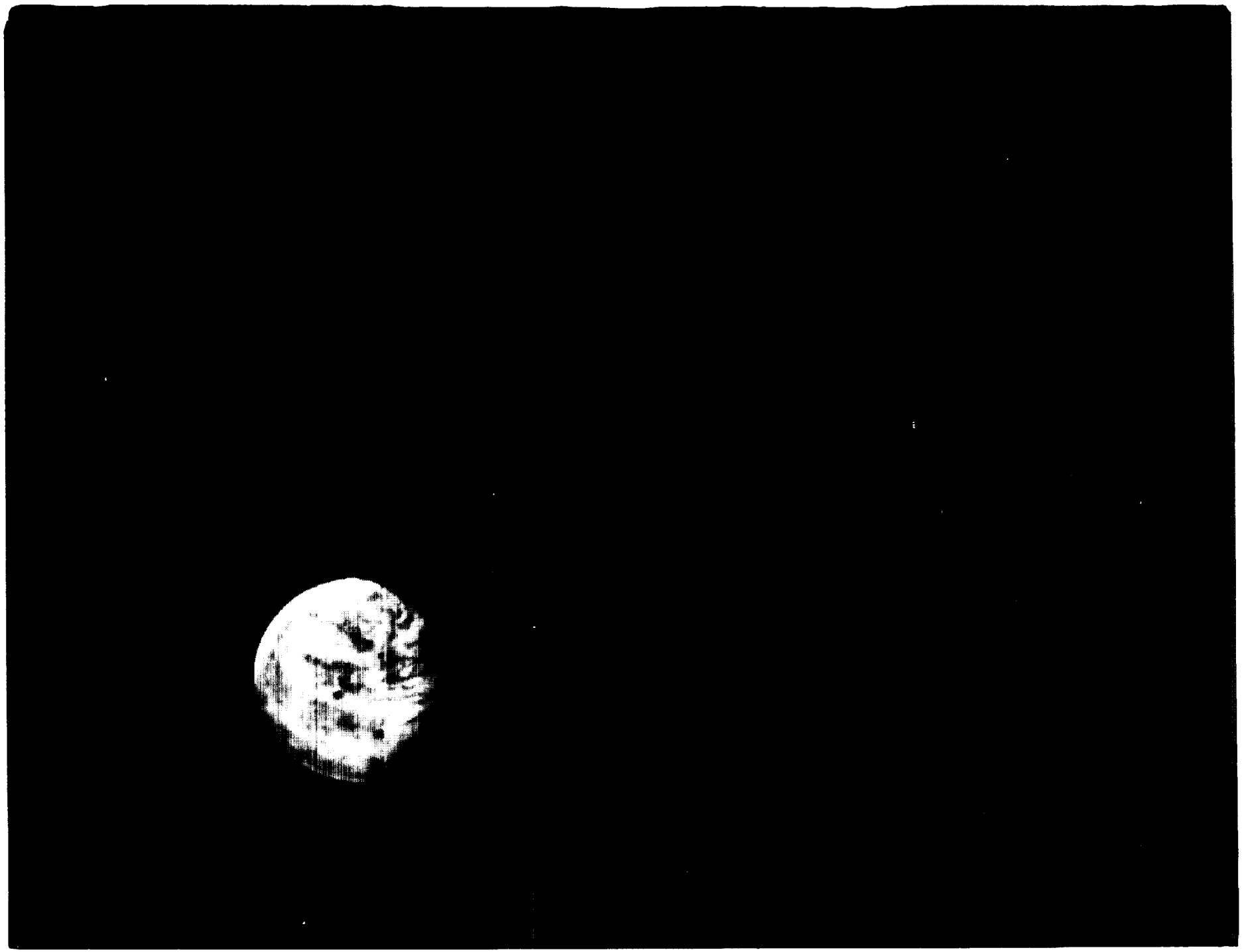
Jupiter and its four planet-sized moons, called Galilean satellites, were photographed in early March by Voyager 1 and assembled into this collage. They are not to scale but are in their relative positions. Startling new discoveries of Voyager 1 concerning the Galilean moons and the planet Jupiter have been factored into a new mission design for Voyager 2. Voyager 2 will fly past Jupiter on July 9. Reddish Io (upper left) is nearest Jupiter; then come Europa (center), Ganymede, and Callisto (lower right). Nine other much smaller satellites circle Jupiter, one inside Io's orbit and the others millions of miles from the planet. Not visible is Jupiter's faint ring of particles, seen for the first time by Voyager 1. The Voyager project is managed for NASA's Office of Space Science by Jet Propulsion Laboratory, California Institute of Technology.

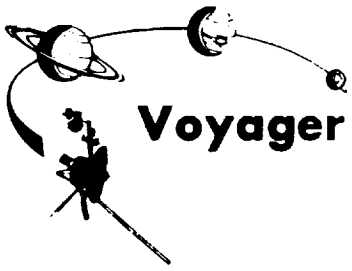




HQ # 79-H-105

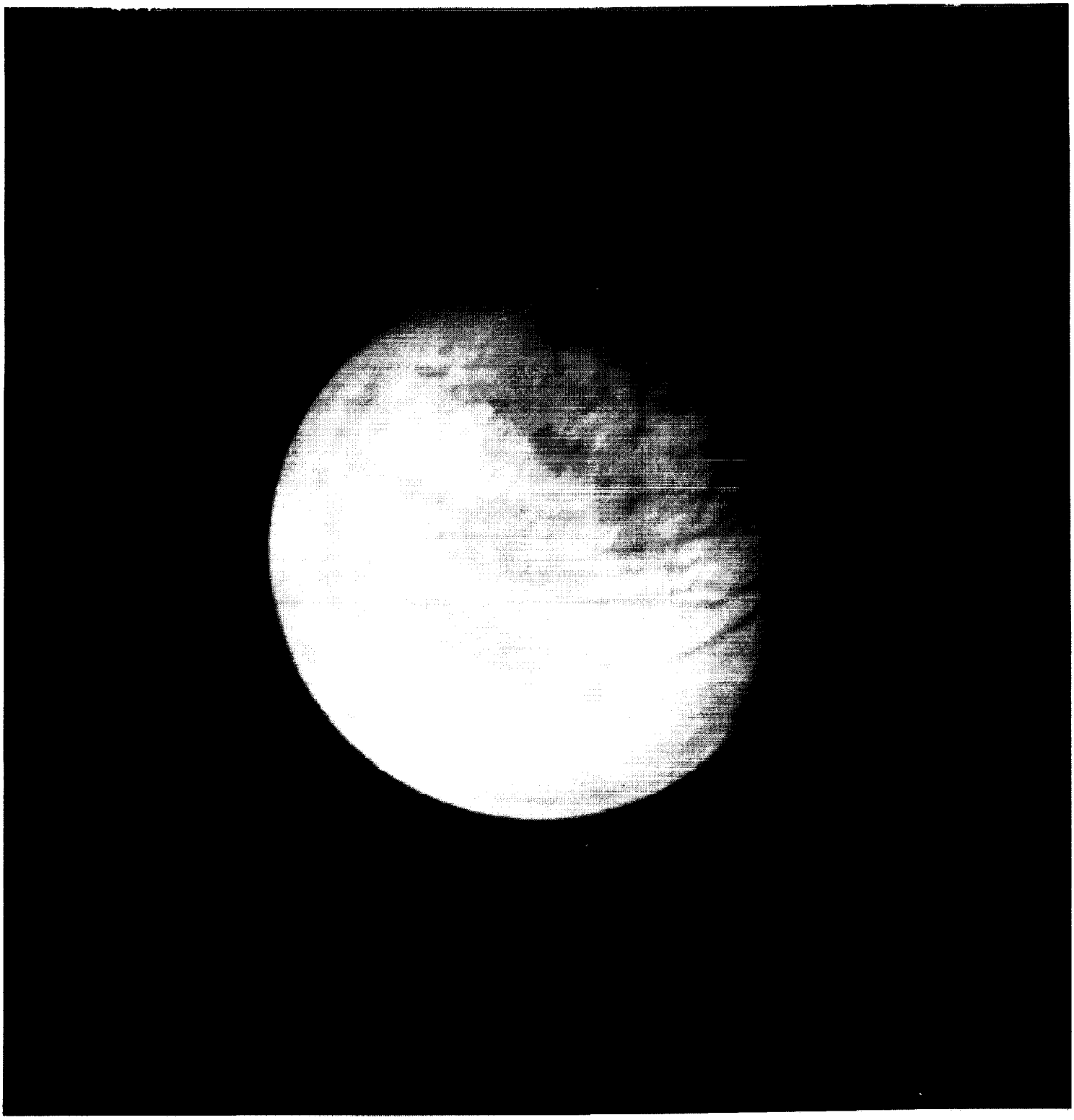
This photo of Europa, brightest of Jupiter's four Galilean satellites, was taken by Voyager 1 on March 2, 1979, from a distance of 2.87 million kilometers (1.75 million miles). In this image a bizarre pattern of dark streaks is becoming visible. The streaks are about 50 kilometers (30 miles) wide, and typically between 2,000 kilometers (1,200 miles) and 3,000 kilometers (1,800 miles) long. They show a variety of forms: straight, arcuate, linear, and branching. Scientists believe they may represent some tectonic system of large fractures or faults. At this resolution it is still too early to tell. In July, Voyager 2 will see the same hemisphere of Europa at much closer range. JPL manages and controls the Voyager project for NASA's Office of Space Science.

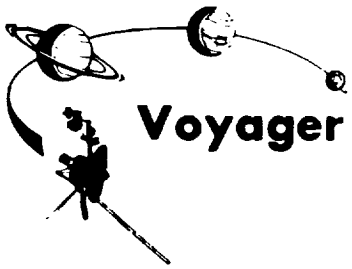




HQ # 79-HC-81
79-H-109

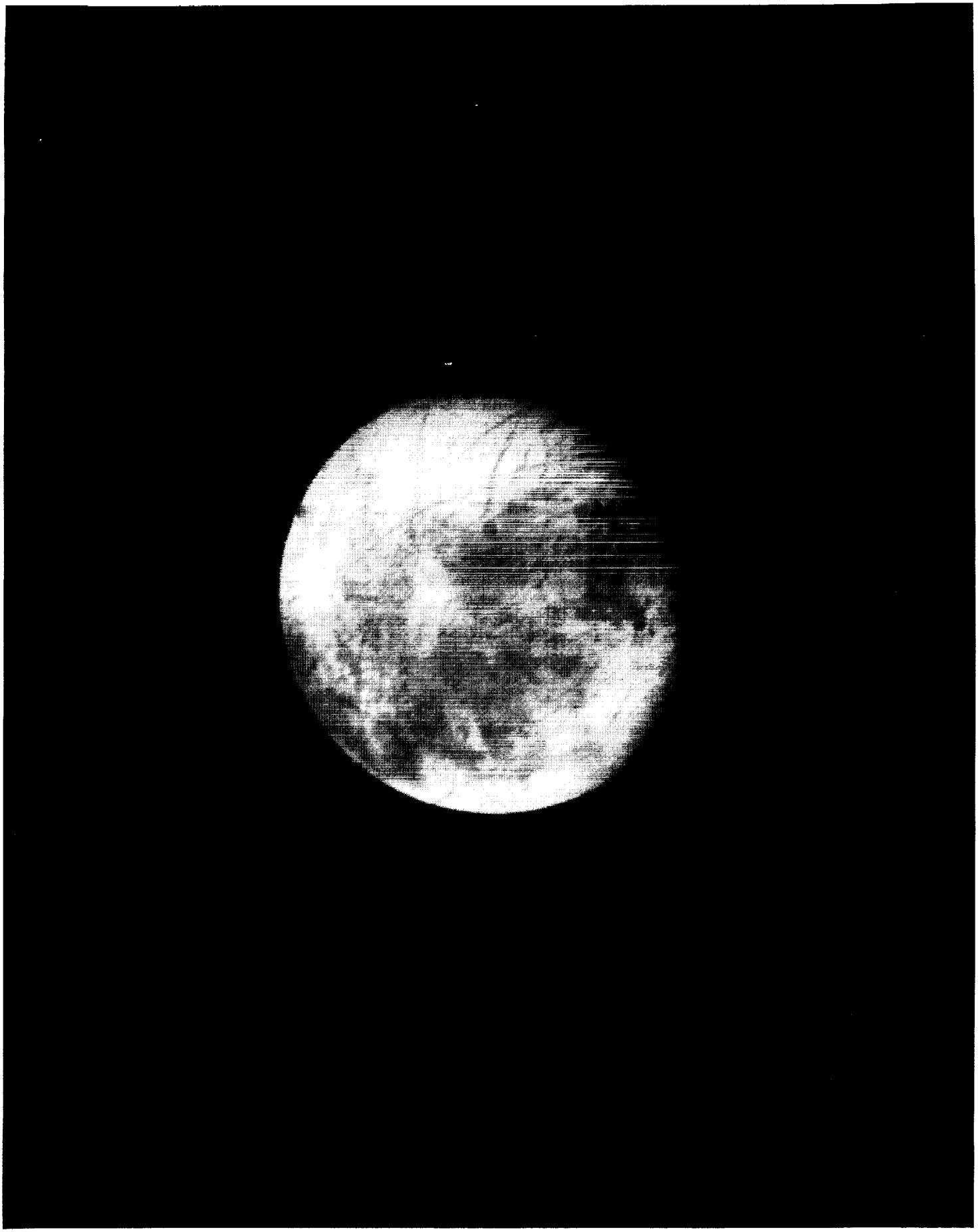
View of Europa taken from a range of 2,869,252 kilometers (1.6 million miles) on March 2 at 2:00 PM. The 170 degrees longitude is at the center of the picture. This is the face away from Jupiter. Irregular dark and bright patches on the surface are different from the patterns on the other satellites of Jupiter and from those on the Moon, Mars, and Mercury. Dark intersecting lines may be faults that break the crust.

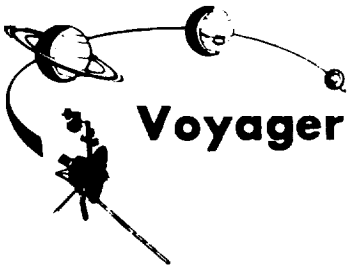




HQ # 79-HC-84

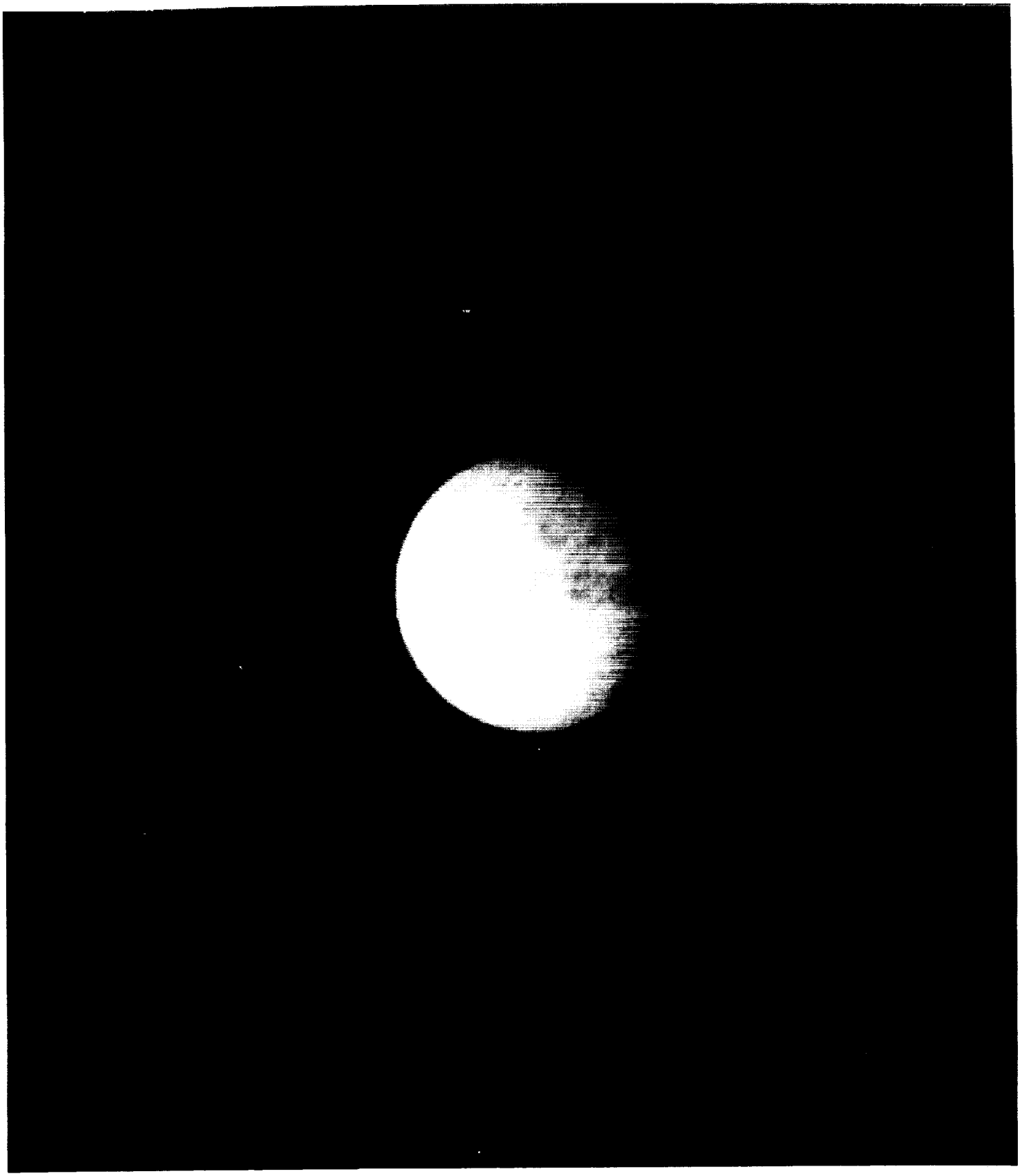
This picture of Europa, the smallest Galilean satellite, was taken on the afternoon of March 4, 1979, from a distance of about 2 million kilometers (1.2 million miles) by Voyager 1. This face of Europa is centered at about 300 degrees meridian. The resolution of this picture of Europa is about the best that will be obtained by Voyager 1, but the second spacecraft will take much clearer photographs of this satellite in July. The bright areas are probably ice deposits, while the darkened areas may be the rocky surface or areas with a more patchy distribution of ice. The most unusual features are the systems of long, linear structures which cross the surface in various directions. Some of these linear structures are over a thousand kilometers (600 miles) long and about two or three hundred kilometers (120-180 miles) wide. They may be fractures or faults which have disrupted the surface.

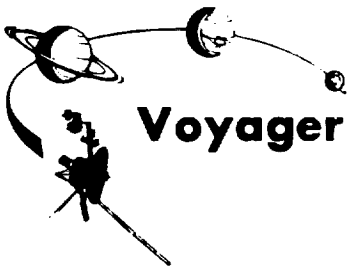




HQ # 79-HC-272
79-H-376

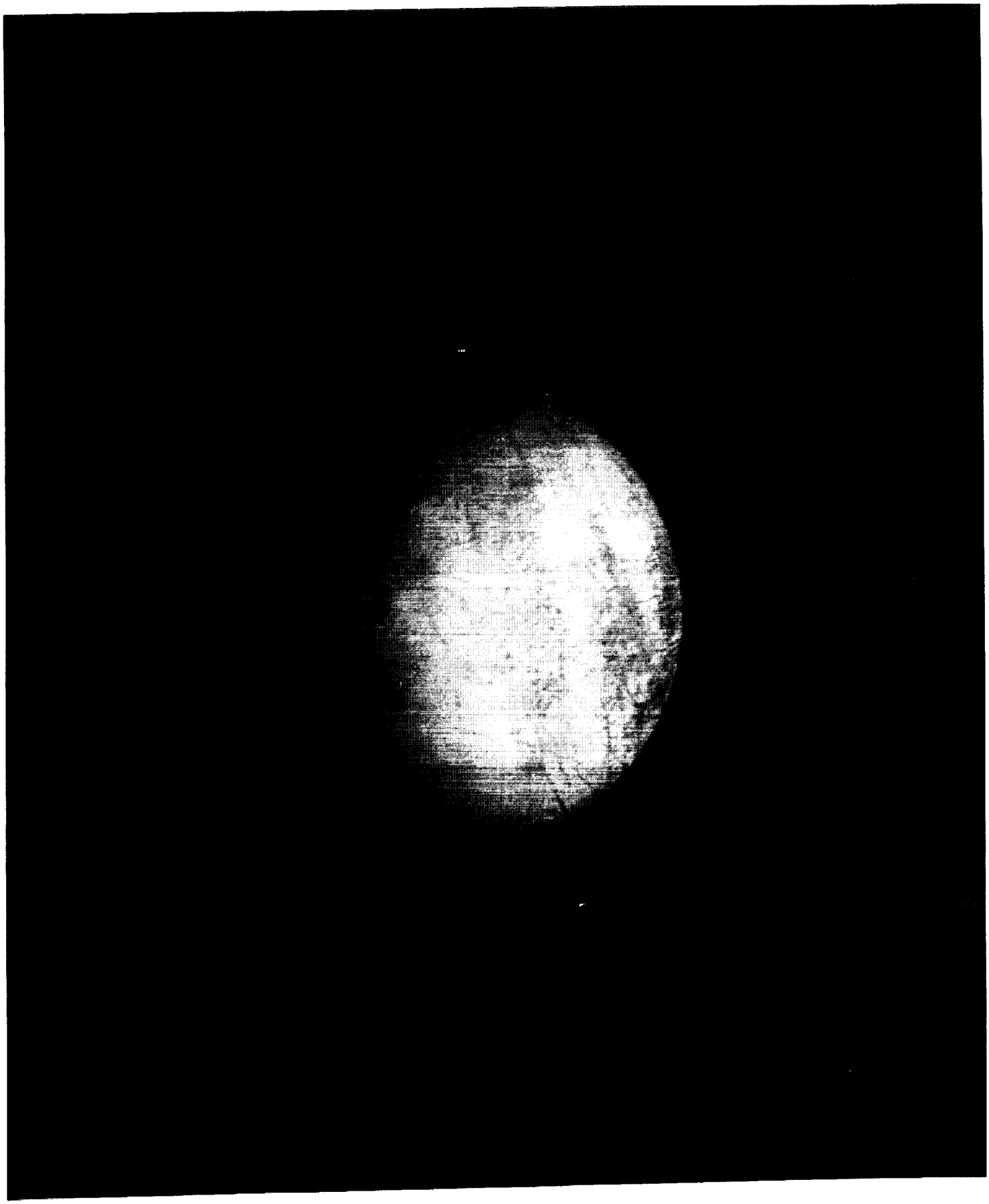
This image of Europa was acquired by Voyager 2 on July 4, from a range of 4.2 million kilometers (2.6 million miles). The central longitude is 235 degrees west. On July 9, Voyager 2 will make its closest approach to Europa, photographing regions on the bright limb (right). Europa, the size of the Earth's Moon, is apparently covered by water ice as indicated by ground-based spectrometers and by its brightness. In this view, global-scale dark streaks discovered by Voyager 1 that crisscross the disk are becoming visible. Bright rayed impact craters which are abundant on ancient Ganymede and Callisto would easily be visible at this range. The suggestion is that Europa's surface is young, and that the streaks are a reflection of currently active internal processes.

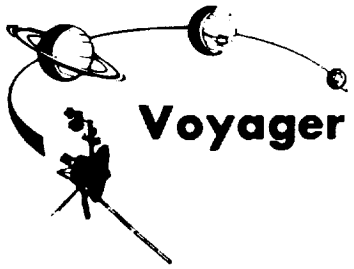




HQ # 79-H-384
79-HC-278

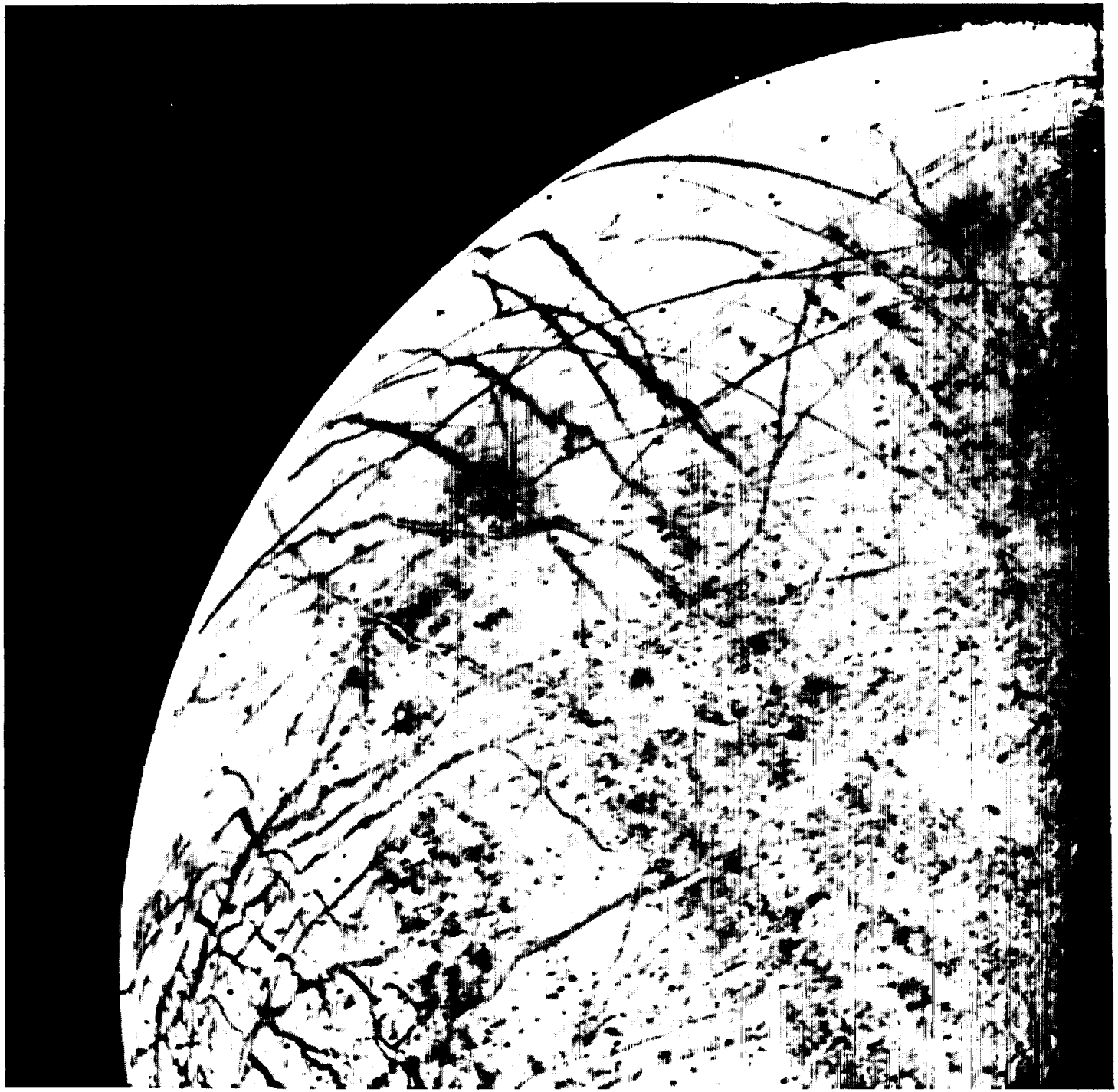
This image of Europa was taken by Voyager 2 at about noon on Sunday, July 8, from a range of 1.2 million kilometers (740,000 miles). It shows detail about 20 kilometers (12 miles) across and is of a somewhat higher resolution than the best Voyager 1 image. The part of Europa shown is the hemisphere that will be viewed at even higher resolution Monday morning during Voyager 2's closest encounter with Europa. Color reconstruction in this image was slightly enhanced to bring out detail in the complicated mottled region on the west limb, containing some of the linear fracture-like features discovered by Voyager 1. The regions in the north and south polar areas that appear bluish in this version are in fact white.

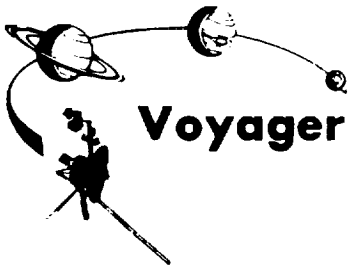




HQ # 79-H-390

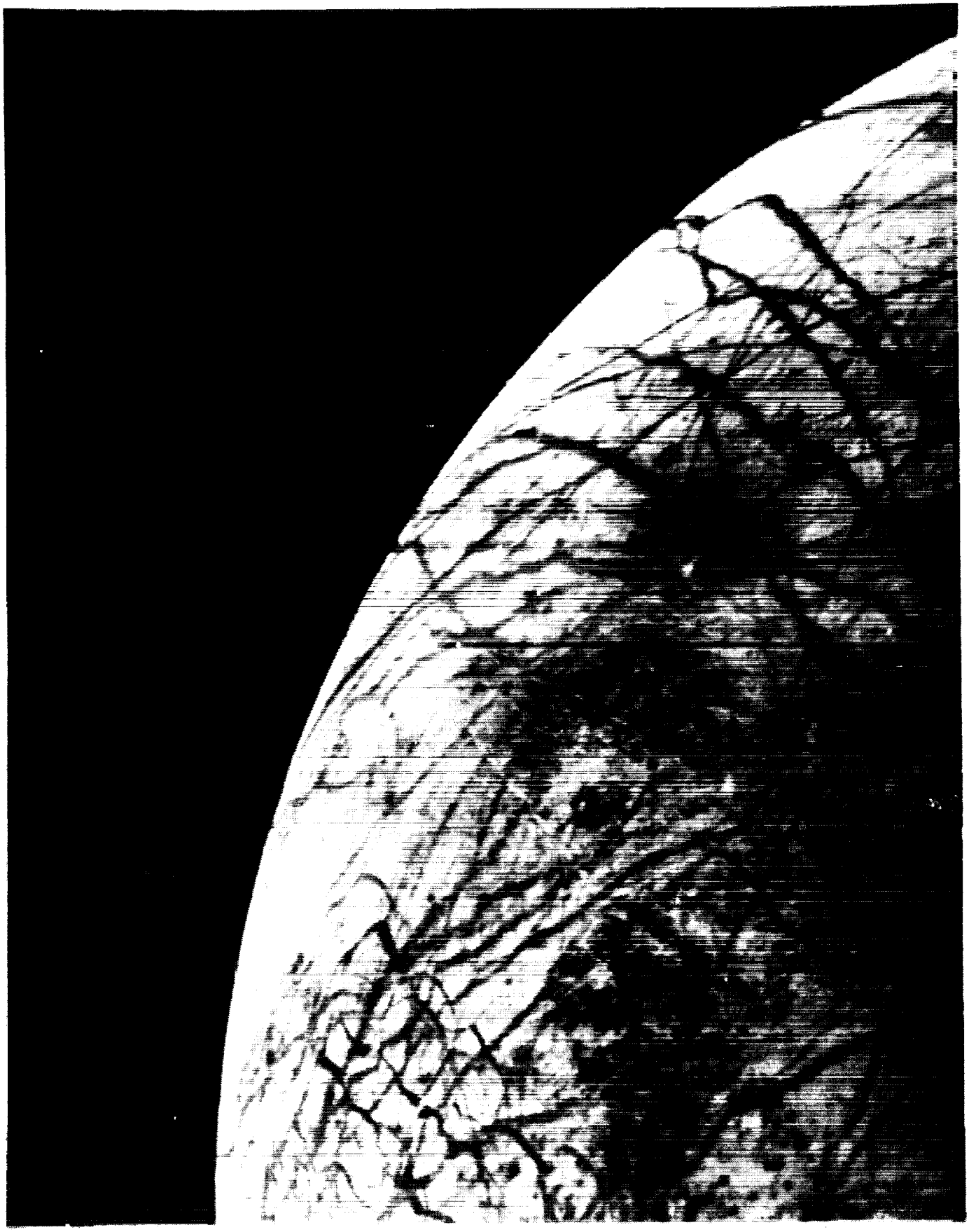
The first close look ever obtained of Jupiter's satellite Europa was taken today, July 9, by Voyager 2 as the spacecraft approached the planet. The linear crack-like features had been seen from a much greater distance last March by Voyager 1. This picture was made at a range of 246,000 kilometers (152,000 miles), and provides a resolution of about four kilometers (2.5 miles). The complicated linear features appear even more like cracks or huge fractures in these images. Also seen are somewhat darker mottled regions which appear to have a slightly pitted appearance, perhaps due to small-scale craters. No large craters (more than 5 kilometers, or 3 miles, in diameter) are easily identifiable in the Europa photographs to date, suggesting that this satellite has a young surface relative to those of Ganymede and Callisto, although not perhaps as young as Io's. Various models for Europa's structure will be tested during analysis of these images, including the possibility that the surface is a thin ice crust overlying water or softer ice, and that the fracture systems seen are breaks in that crust. Resurfacing mechanisms such as production of fresh ice or snow along the cracks and cold glacier-like flows are being considered as possibilities for removing evidence of impact events. Europa thus appears to be truly a satellite with many properties intermediate between those of Ganymede and Io.

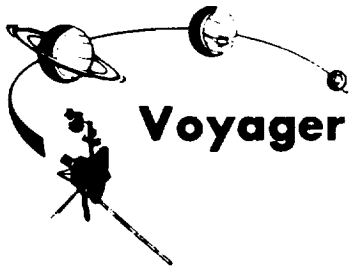




HQ # 79-H-392
79-HC-282

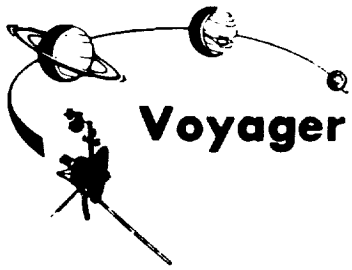
This color image of the Jovian moon Europa was acquired by Voyager 2 during its close encounter on Monday morning, July 9. Europa, the size of our Moon, is thought to have a crust of ice perhaps 100 kilometers (60 miles) thick which overlies the silicate crust. The complex array of streaks indicate that the crust has been fractured and filled by materials from the interior. The lack of relief (any visible mountains or craters) on its bright limb is consistent with a thick ice crust. In contrast to its icy neighbors, Ganymede and Callisto, Europa has very few impact craters. One possible candidate is the small feature near the center of this image with radiating rays and a bright circular interior. The relative absence of features and low topography suggest that the crust is young and warm a few kilometers below the surface. The tidal heating process suggested for Io may also be heating Europa's interior, although at a lower rate.





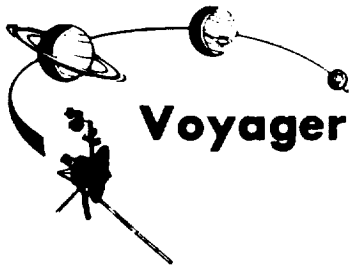
HQ # 79-H-396
79-HC-286

This color image of Europa, smallest of Jupiter's four Galilean satellites, was acquired by Voyager 2 on July 9, 1979, from a range of 241,000 kilometers (150,600 miles). Europa, the brightest of the Galilean satellites, has a density slightly less than that of Io, suggesting that it has a substantial quantity of water. Scientists previously speculated that the water must have cooled from the interior and formed a mantle of ice perhaps 100 kilometers (60 miles) thick. The complex patterns on its surface suggest that the icy surface was fractured, and that the cracks filled with dark material from below. Very few impact craters are visible on the surface, suggesting that active processes on the surface are still modifying Europa. The tectonic pattern seen on its surface differs drastically from the fault systems seen on Ganymede, where pieces of the crust have moved relative to each other. On Europa, the crust evidently fractures but the pieces remain in roughly their original position.



HQ # 79-H-397

This color image of Europa, smallest of Jupiter's four Galilean satellites, was acquired by Voyager 2 on July 9, 1979, from a range of 241,000 kilometers (150,600 miles). Europa, the brightest of the Galilean satellites, has a density slightly less than that of Io, suggesting that it has a substantial quantity of water. Scientists previously speculated that the water must have cooled from the interior and formed a mantle of ice perhaps 100 kilometers (60 miles) thick. The complex patterns on its surface suggest that the icy surface was fractured, and that the cracks filled with dark material from below. Very few impact craters are visible on the surface, suggesting that active processes on the surface are still modifying Europa. The tectonic pattern seen on its surface differs drastically from the fault systems seen on Ganymede, where pieces of the crust have moved relative to each other. On Europa, the crust evidently fractures but the pieces remain in roughly their original position.

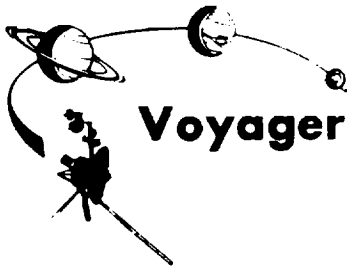


HQ # 79-H-398

This image of the Jovian moon Europa was taken by Voyager 2 July 9, 1979, as the spacecraft passed within 225,000 kilometers (140,700 miles). The area shown is about 600 by 800 kilometers (370 by 500 miles), and the smallest features visible are about four kilometers (2.5 miles) in size. This image was taken along the evening terminator, which best shows the surface topography of complex narrow ridges, seen as curved bright streaks 5 to 10 kilometers (3 to 5 miles) wide, and typically 100 kilometers (60 miles) in length. Also visible are dark bands, more diffuse in character, 20 to 40 kilometers (12 to 24 miles) wide and hundreds to thousands of kilometers in length. A few features are suggestive of impact craters, but these are rare, indicating that the surface thought to be dominantly ice is still active, perhaps warmed by tidal heating like Io. The larger icy satellites, Callisto and Ganymede, are evidently colder with much more rigid crusts and ancient impact craters. The complex intersecting of dark markings and bright ridges suggests that the surface has been fractured and material from beneath has welled up to fill the cracks.

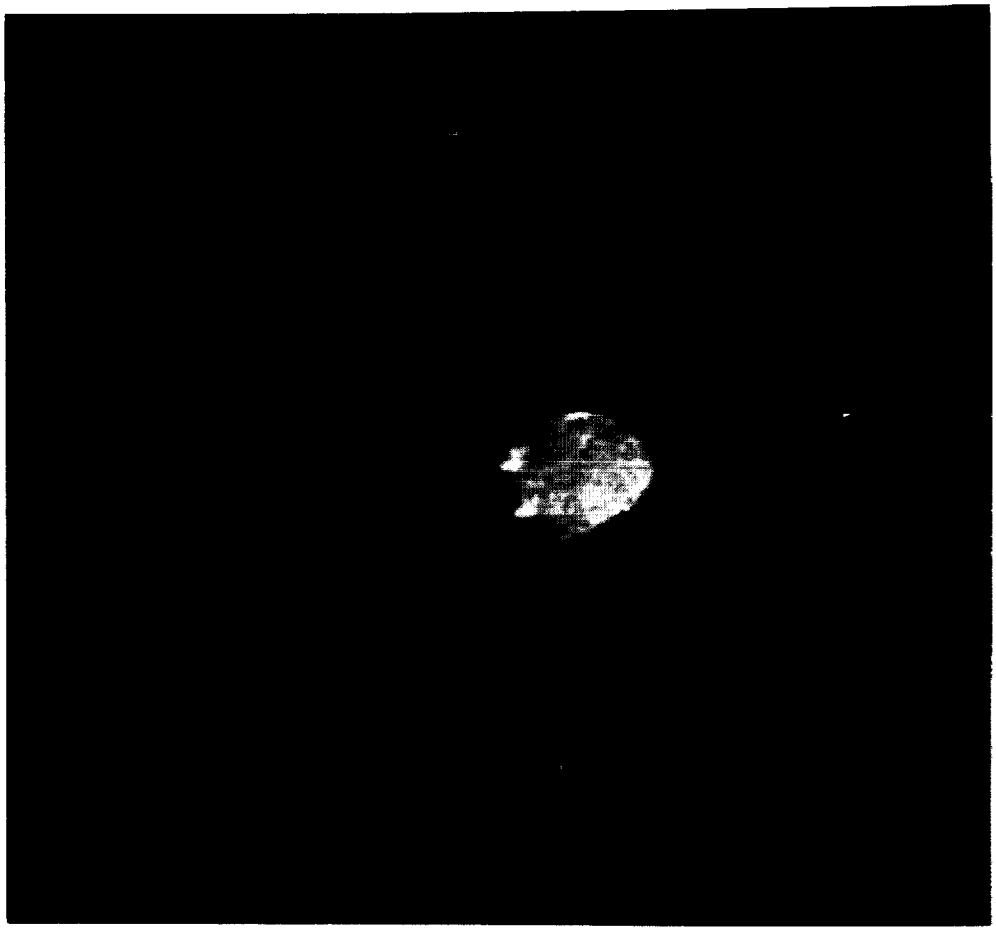
NASA National Aeronautics and Space Administration

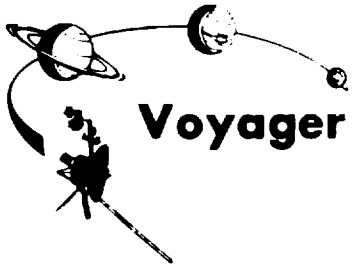
Washington, D.C.



HQ # 79-HC-85

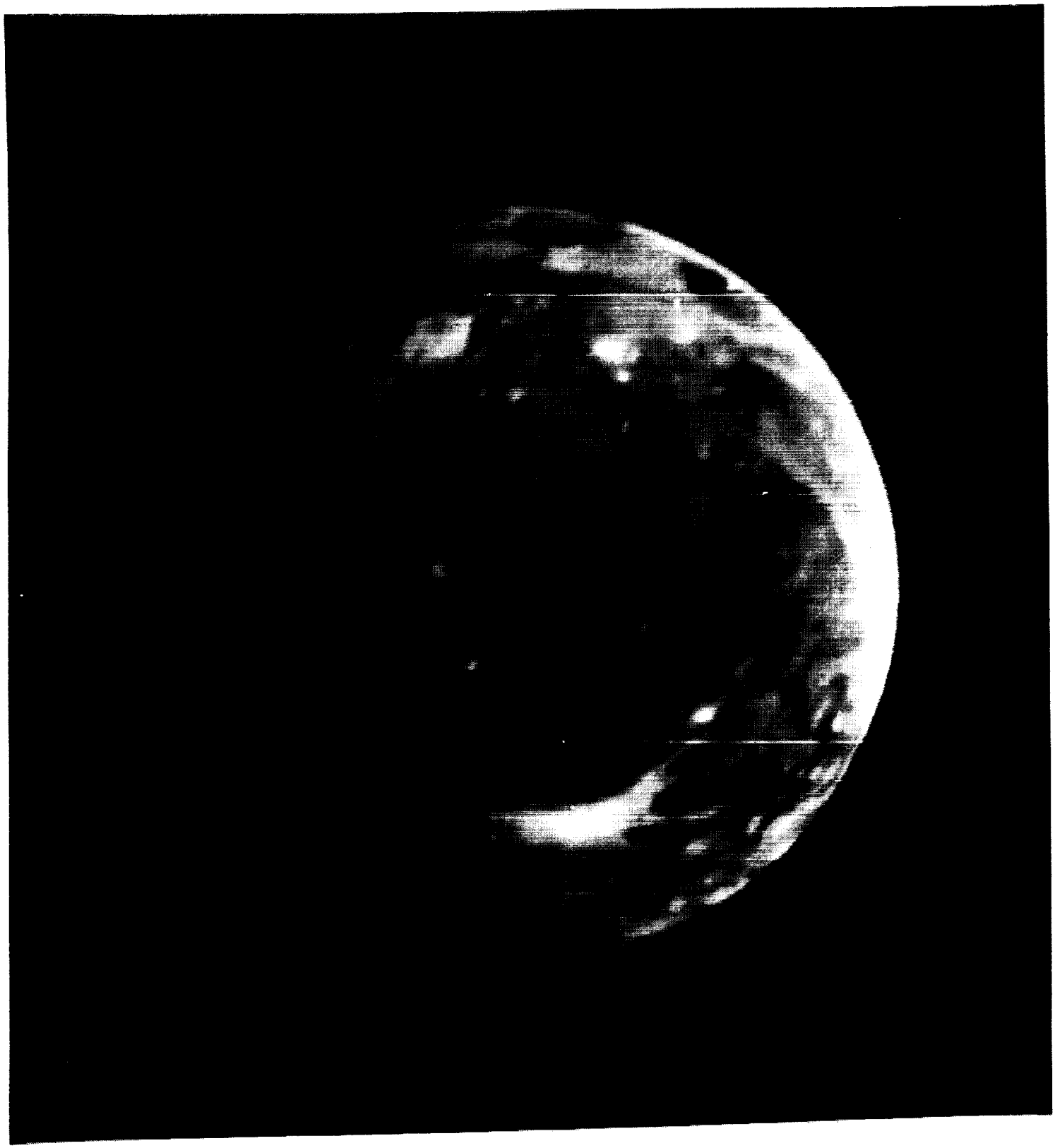
Tiny, red Amalthea, Jupiter's innermost satellite, whizzes around the planet every 12 hours only 1.55 Jupiter radii from the cloud tops. In this view, taken from a range of 425,000 kilometers (255,000 miles) on March 4 by Voyager 1, the satellite appears to be about 130 kilometers (80 miles) high by 170 kilometers (100 miles) wide. Since the phase angle is 29.5, part of the longer dimension is not illuminated. The terminator is on the right, north is at top, Jupiter is to the left. The reflectivity of the surface is less than 10%, making Amalthea much darker than the Galilean satellites. Amalthea's irregular shape probably results from a long history of impact cratering. Some of the indentations near the bottom and at upper right may be marginally resolved craters. (The effective resolution of this image is about eight kilometers, or five miles.) An important question is whether, as is more likely, it results from a coating or alteration of the surface material. This irregular satellite probably keeps its long axis pointed toward Jupiter in its motion around the planet, so that the spin period around its own axis equals its period of revolution around Jupiter (12 hours). Unlike the four large Galilean satellites, which have been known since 1610, Amalthea was discovered only 87 years ago, in 1892, by the American astronomer Edmund Emerson Barnard, at Lick Observatory.

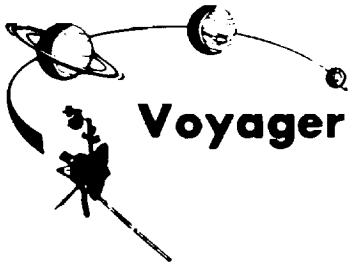




HQ # 79-HC-77
79-H-102

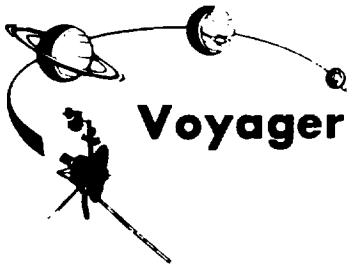
This picture of Ganymede, Jupiter's largest satellite, was taken on the afternoon of March 2, 1979, by Voyager 1 from a distance of about 3.4 million kilometers (2.1 million miles). This photograph was assembled from three black-and-white pictures in the Image Processing Laboratory at JPL. This face of Ganymede is centered on the 260 degrees meridian. Ganymede is slightly larger than the planet Mercury but has a density almost three times less than that of Mercury. Therefore, Ganymede probably consists in large part of ice. At this resolution, the surface shows light and dark markings interspersed with bright spots. The large darkish area near the center of the satellite is crossed by irregular light streaks somewhat similar to rays seen on the Moon. The bright patch in the southern hemisphere is reminiscent of some of the larger rayed craters on the Moon, caused by meteorite impacts.





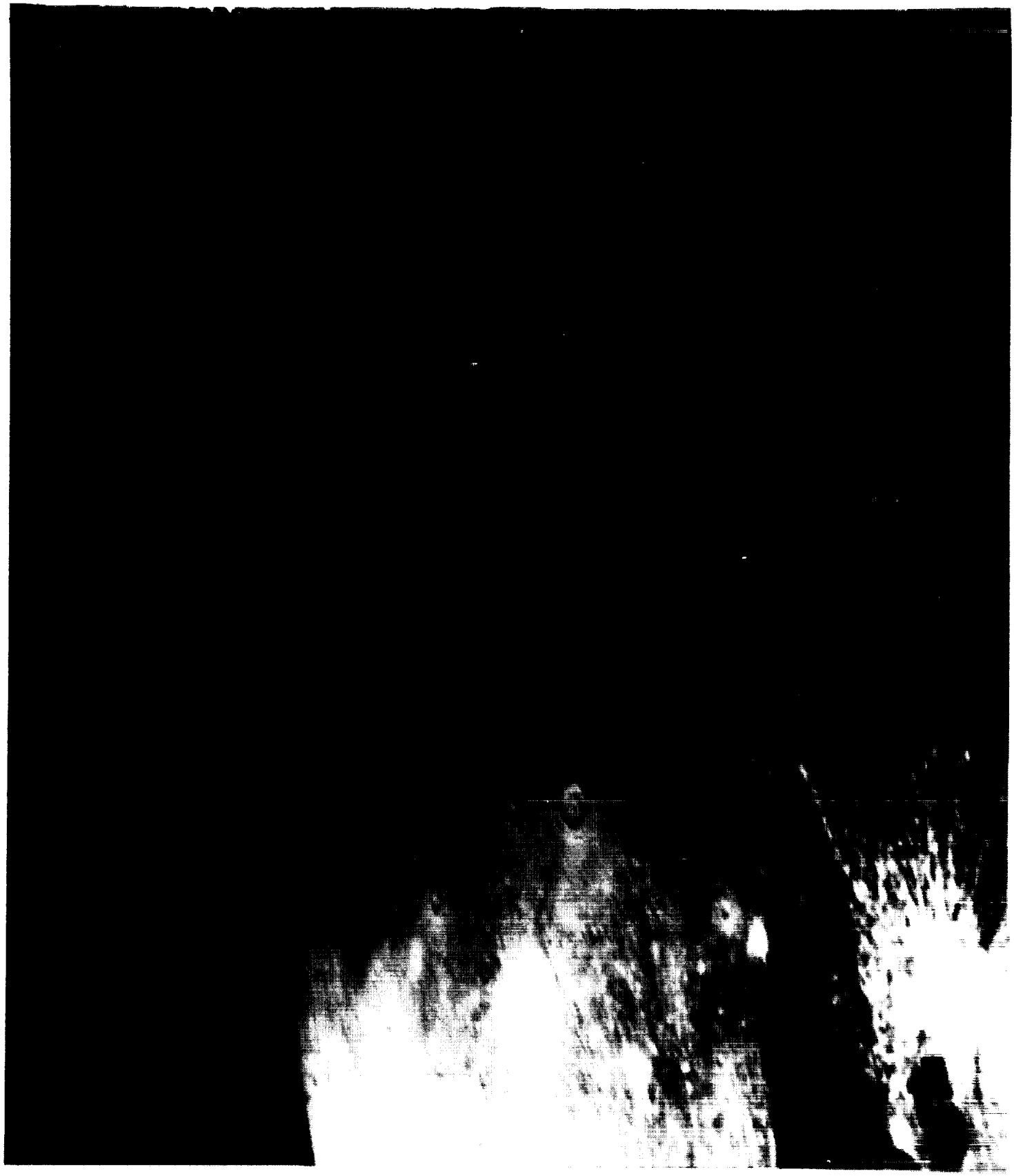
HQ # 79-HC-83

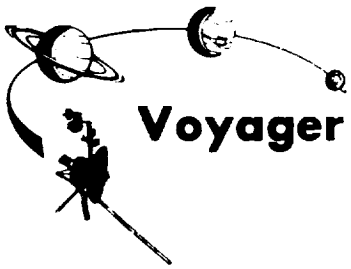
This picture was taken on March 4, 1979, at 2:30 a.m. PST by Voyager 1 from a distance of 2.6 million kilometers (1.6 million miles). Ganymede is Jupiter's largest satellite, with a radius of about 2,600 kilometers, or about 1.5 times that of our Moon. Ganymede has a bulk density of only approximately 2.0 g/cc, almost half that of our Moon. Therefore, Ganymede is probably composed of a mixture of rock and ice. The features here, the large regions in the northwest quadrant, and the white spots, resemble features found on the Moon, mare, and impact craters, respectively. The long white filaments resemble rays associated with impacts on the lunar surface. The various colors of different regions probably represent differing surface materials. The colored dots on the picture (blue, green, and orange) are the results of markings on the camera used for pointing determinations, and are not physical markings.



JPL # P-21261 B/W

This color picture was acquired by Voyager 1 during its approach to Ganymede on Monday afternoon, March 5, at a range between about 230,000 and 250,000 kilometers (143,000 to 155,000 miles). The image shows detail on the surface with a resolution of 4.5 kilometers (2.8 miles). The photo depicts a region in the northern hemisphere near the terminator (top of photo is at left). It shows a variety of impact structures, including both razed and unrazed craters, and, in the lighter regions, the odd, groove-like structures discovered by Voyager. The most striking features are the bright ray craters, which have a distinctly "bluer" color, appearing white against the redder background. Ganymede's surface is known to contain large amounts of surface ice, and it appears that these relatively young craters have spread bright, fresh ice materials over the surface. Likewise, the lighter color and higher reflectivity of the grooved areas suggests that here, too, there is cleaner ice. We see ray craters with all sizes of ray patterns, ranging from extensive systems of the crater in the southern part of the picture (and the northern part of the following picture), which has rays at least 300-500 kilometers (185-310 miles) long, down to craters which have only faint remnants of bright ejecta patterns (such as several of the craters in the southern half of the following picture). This variation suggests that, as on the Moon, there are processes which act to darken ray material, probably "gardening" by micrometeoroid impact. JPL manages and controls the Voyager project for NASA's Office of Space Science.





HQ # 79-H-121
79-HC-100

This color picture was acquired by Voyager 1 during its approach to Ganymede on Monday afternoon, March 5, at a range between about 230,000 and 250,000 kilometers (430,000 to 155,000 miles). The image shows detail on the surface with a resolution of 4.5 kilometers (2.8 miles). The area in this picture is just south of the area in the previous picture, and shows more craters. It also shows the two distinctive types of terrain found by Voyager—the darker, ungrooved regions and the lighter areas which show the grooves or fractures in abundance. The most striking features are the bright ray craters, which have a distinctly "bluer" color, appearing white against the redder background. Ganymede's surface is known to contain large amounts of surface ice, and it appears that these relatively young craters have spread bright, fresh ice materials over the surface. Likewise, the lighter color and higher reflectivity of the grooved areas suggest that here too, there is cleaner ice. We see ray craters with all sizes of ray patterns, ranging from extensive systems of the crater in the southern part of the previous picture (northern part of this photo), which has rays at least 300 to 500 kilometers (185 to 310 miles) long, down to craters which have only faint remnants of bright ejecta patterns (such as several of the craters in the southern half of this picture). This variation suggests that, as on the Moon, there are processes which act to darken ray material, probably "gardening" by micrometeoroid impact.

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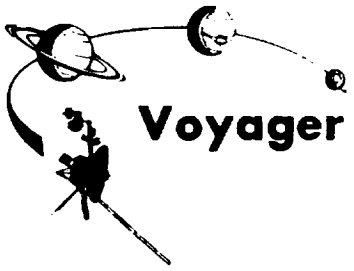
PHOTO CAPTION

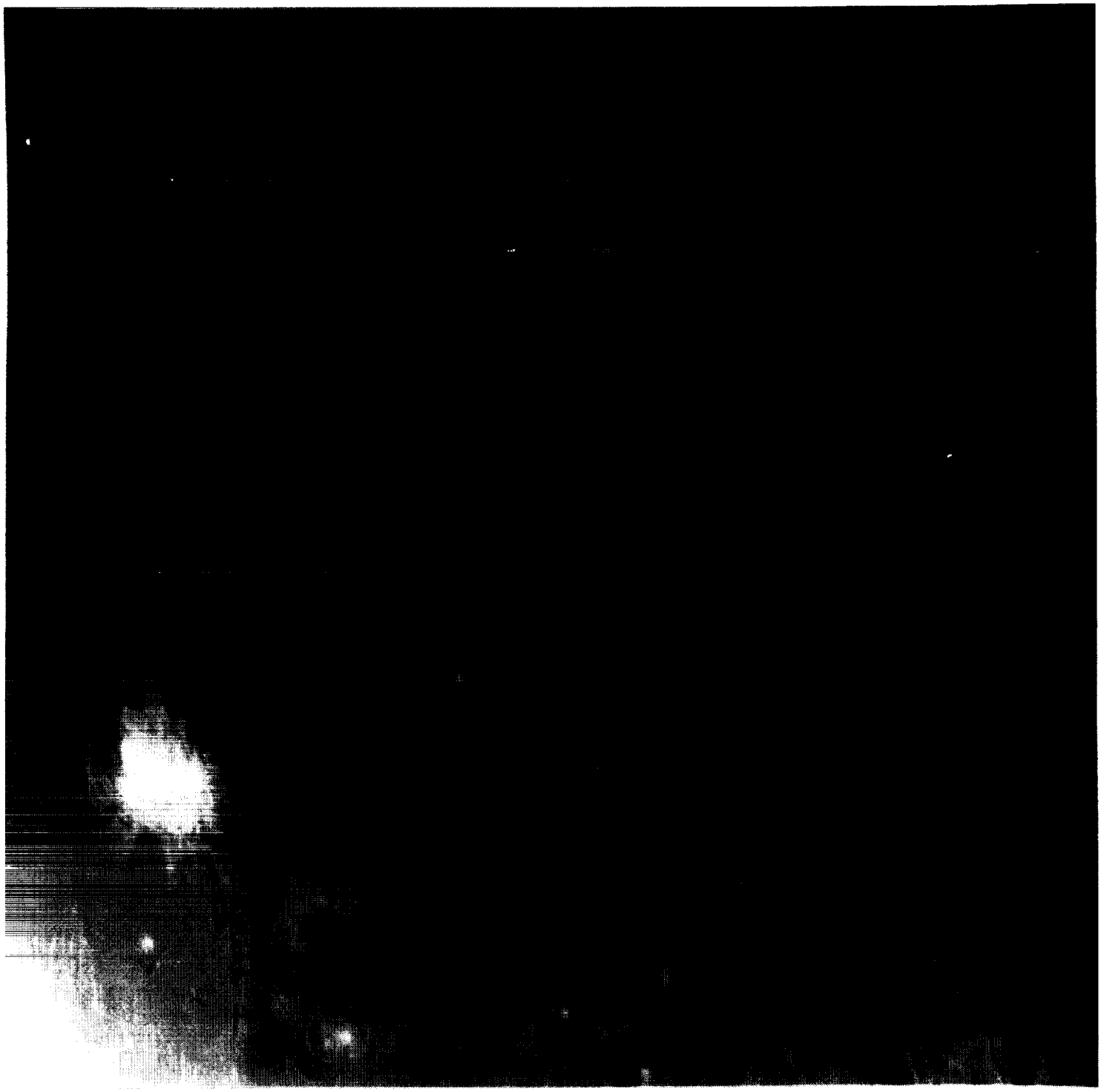
Voyager 1-112
P-21262 C
March 7, 1979

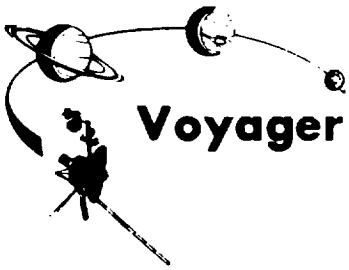
This color picture as acquired by Voyager 1 during its approach to Ganymede on Monday afternoon (the 5th of March). At ranges between about 230 to 250 thousand km. The images show detail on the surface with a resolution of four and a half km. Picture 2 (P-21262) is just south of Picture 1 and shows more craters. It also shows the two distinctive types of terrain found by Voyager, the darker ungrooved regions and the lighter areas which show the grooves or fractures in abundance. The most striking features are the bright ray craters which hav a distinctly "bluer" color appearing white against the redder background. Ganymede's surface is known to contain large amounts of surface ice and it appears that these releatively young craters have spread bright fresh ice materials over the surface. Likewise, the lighter color and reflectivity of the grooved areas suggests that here too, there is cleaner ice. We see ray craters with all sizes of ray patterns, ranging from extensive systems of the crater in the southern part of Picture 1 (northern part of Picture 2), which has rays at least 300-500 kilometers long, down to craters which have only faint remnants of bright ejecta patterns (such as several of the craters in the southern half of Picture 2). This variation suggests that, as on the Moon, there are processes which act to darken ray material, probably "gardening" by micrometeoroid impact. JPL manages and controls the Voyager project for NASA's Office of Space Science.



JPL # P-21263 C

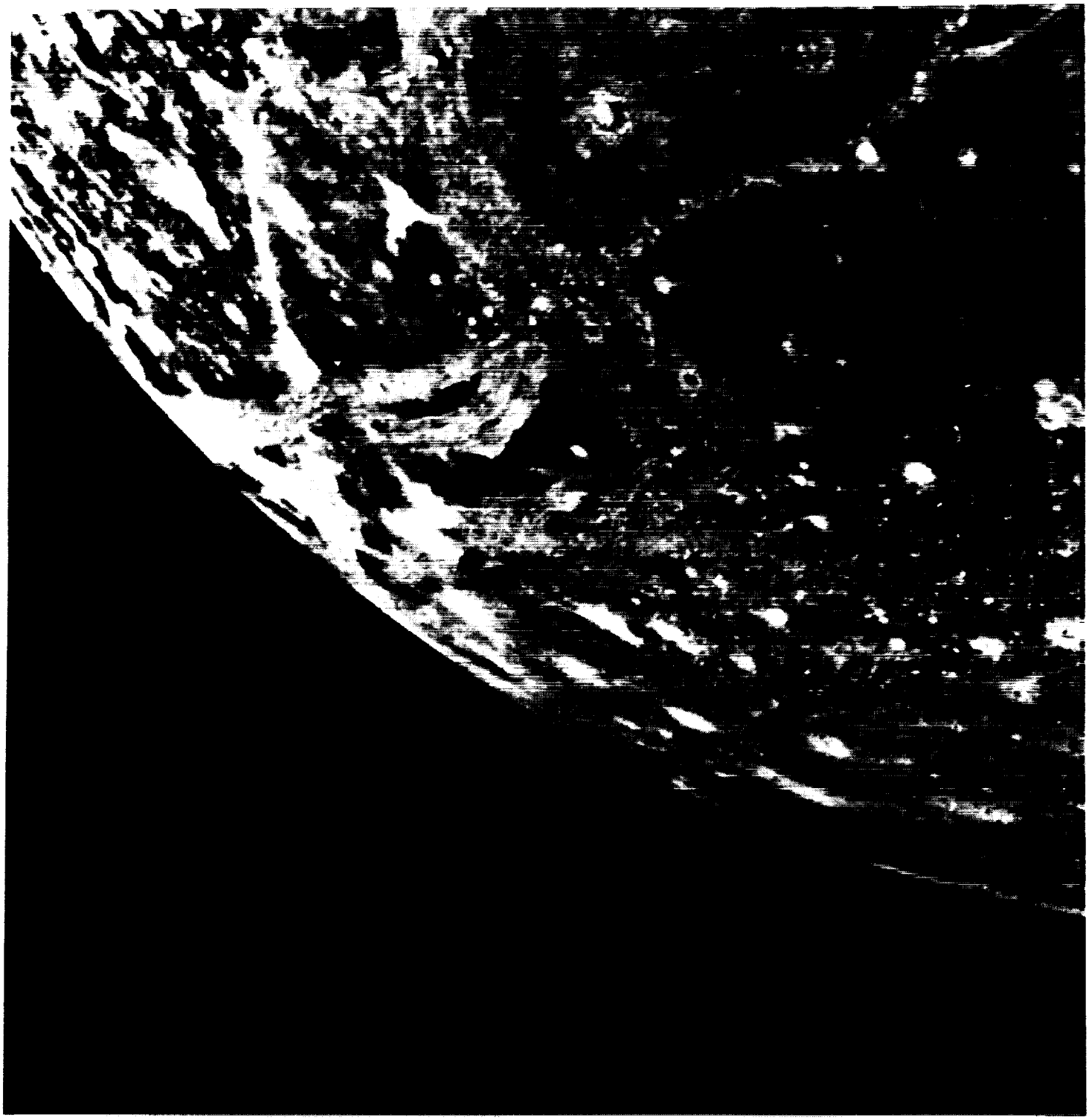
This color picture was acquired by Voyager 1 during its approach to Ganymede on Monday afternoon, March 5, at a range between about 230,000 and 250,000 kilometers (143,000 to 155,000 miles). The images show detail on the surface with a resolution of 4.5 kilometers (2.8 miles). The area in this photo is south of the area in the preceding picture (79-HC-100), near the equator of Ganymede. It has relatively subdued colors in the visible part of the spectrum (later, scientists will analyze Voyager pictures taken in UV). The most striking features are the bright ray craters, which have a distinctly "bluer" color appearing white against the redder background. Ganymede's surface is known to contain large amounts of surface ice, and it appears that these relatively young craters have spread fresh ice materials over the surface. Likewise, the lighter color and higher reflectivity of the grooved areas suggest that here, too, there is cleaner ice. We see ray craters with all sizes of ray patterns, ranging from extensive systems of the crater in the preceding two photos which have rays at least 300 to 500 kilometers (186 to 310 miles) long, down to craters which have only faint remnants of bright ejecta patterns. This variation suggests that, as on the Moon, there are processes which act to darken ray material, probably "gardening" by micrometeoroid impact. JPL manages and controls the Voyager project for NASA's Office of Space Science.

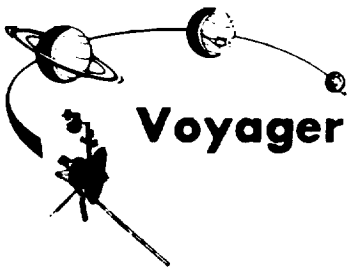




JPL # P-21265 B/W

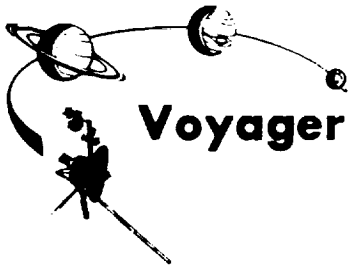
This picture of Ganymede, Jupiter's largest satellite, was taken by Voyager 1 on the afternoon of March 5, 1979, from a range of 253,000 kilometers (151,800 miles). The picture is centered at 60 degrees south latitude and three degrees longitude, and shows the southwestern limb region of Ganymede. The smallest features visible are about 2.5 kilometers (1.5 miles) across. The surface shows numerous impact craters, many of which have extensive, bright ray systems. Light bands traversing the surface contain alternating bright and dark lines which probably represent deformation of the icy central material. JPL manages and controls the Voyager project for NASA's Office of Space Science.





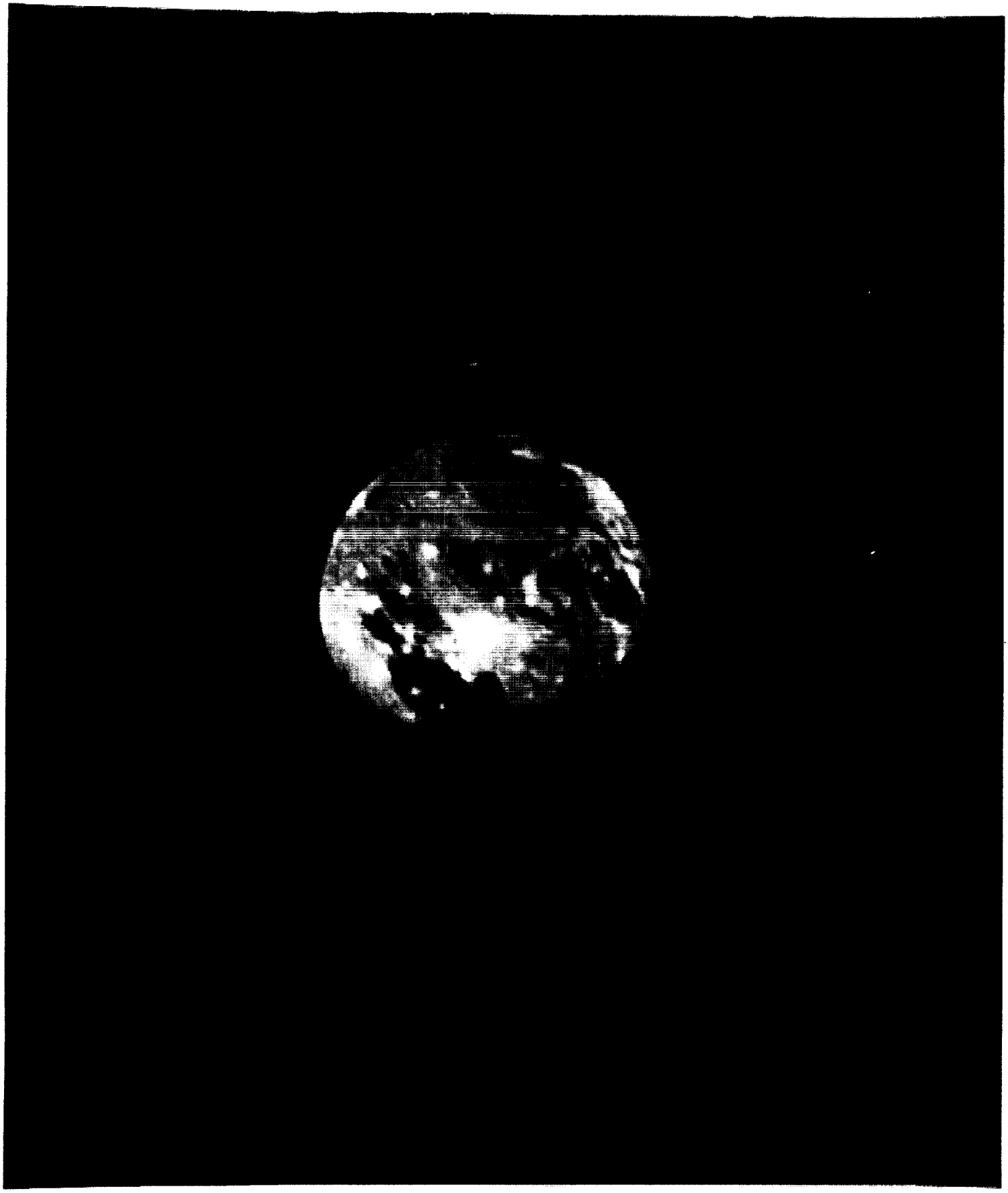
JPL # P-21267 B/W

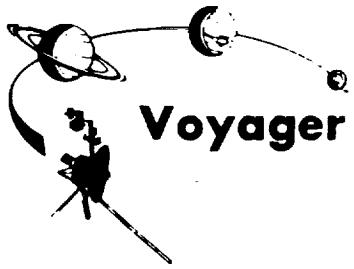
This view of Ganymede was taken on the afternoon of March 5 from a range of 267,000 kilometers (167,000 miles). A bright rayed impact crater is prominent on the left side of the frame. The ejecta material extends for a thousand kilometers (600 miles). The rays are on top and, therefore, are younger than the brighter ridged and grooved terrain crossing the picture. These features may be breaks in the surface caused by faulting. Many older craters are visible that have lost their rays. JPL manages and controls the Voyager Project for NASA's Office of Space Science.



HQ # 79-HC-275
79-H-381

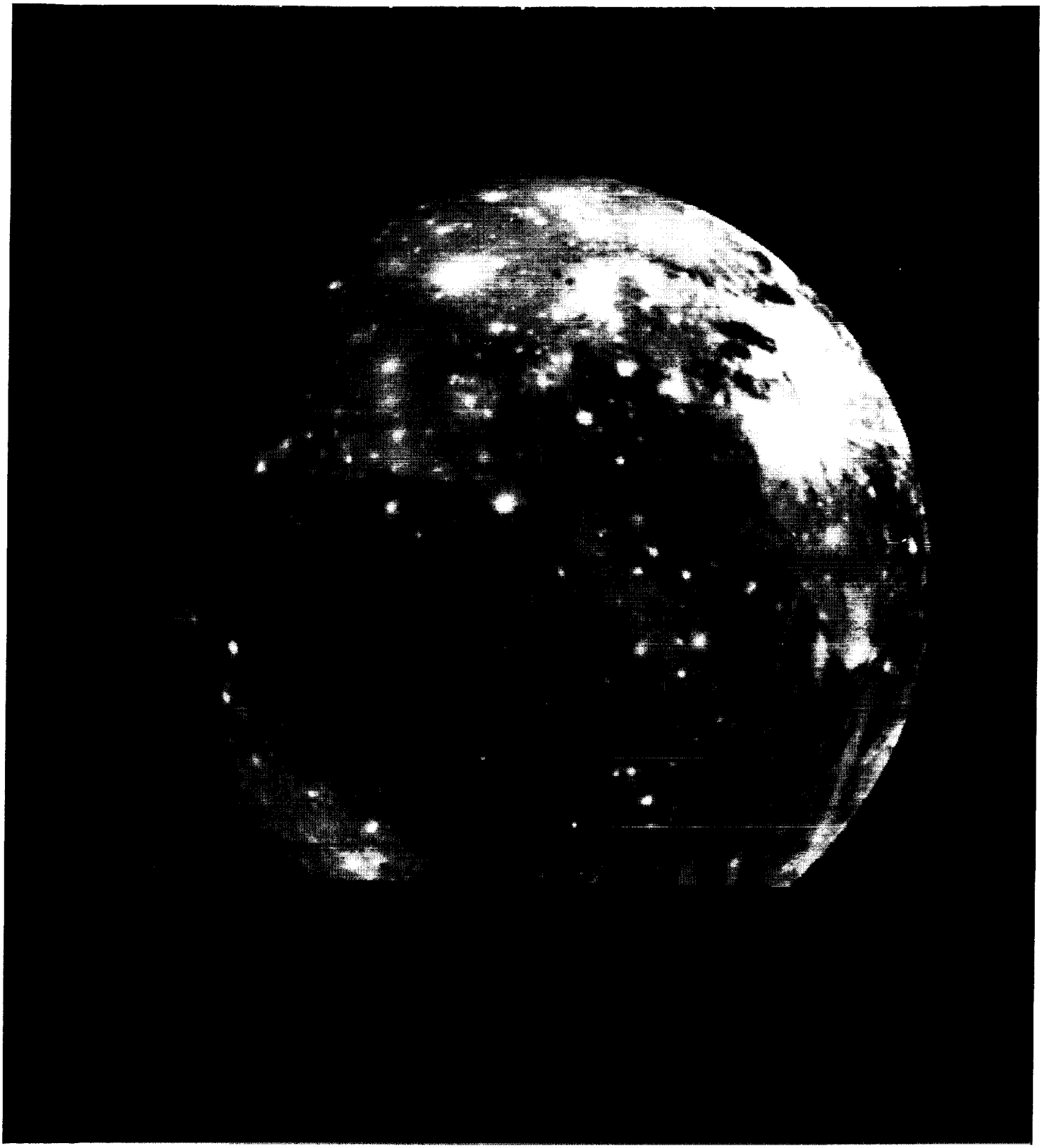
Voyager 2 obtained this photo of Ganymede, the largest satellite of Jupiter, on July 2, 1979, from a distance of six million kilometers (four million miles). The side of the satellite shown is approximately the same as that photographed at close range by Voyager 1 in March. This picture illustrates well the light-colored bluish regions near the north and south poles. It is known that there is exposed water ice on the surface of Ganymede, and perhaps these polar caps are composed of a light covering of water ice or frost. Voyager 2 will pass within 63,000 kilometers (39,000 miles) of Ganymede at about midnight, July 8, on its way toward the giant planet.

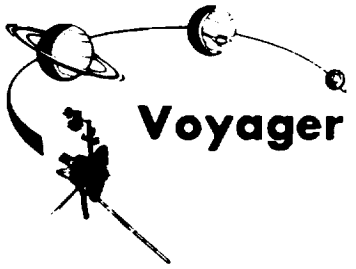




HQ # 79-H-383
79-HC-277

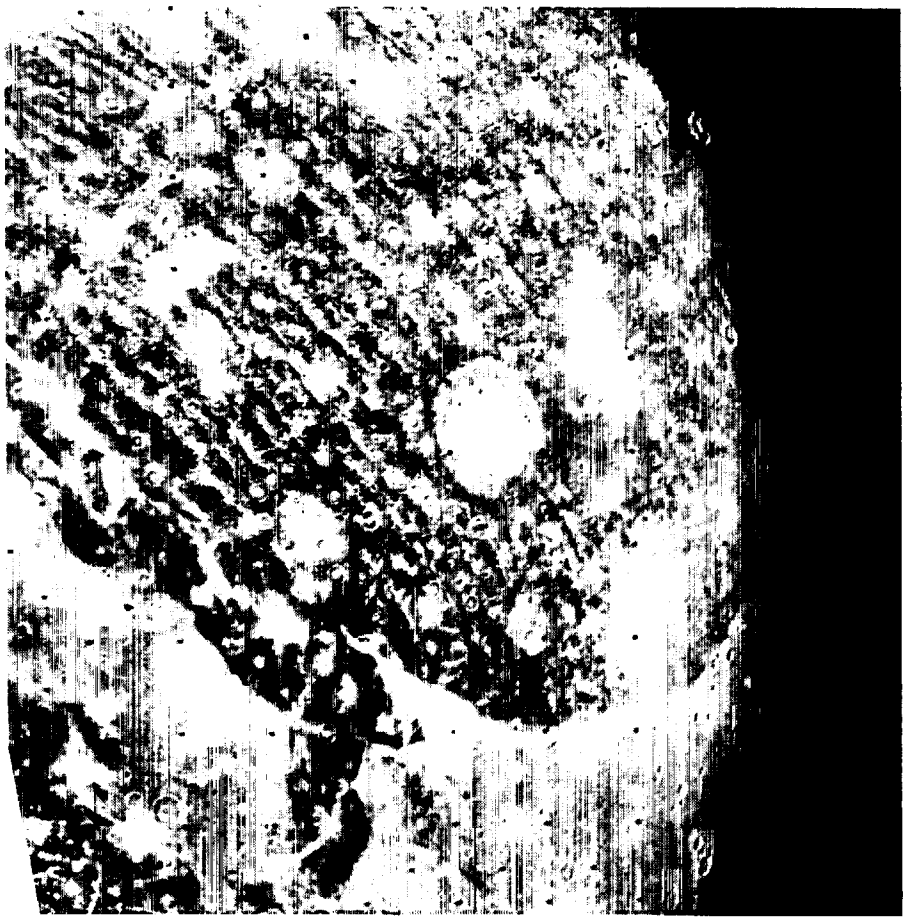
This Voyager 2 color photo of Ganymede, the largest Galilean satellite, was taken on July 7, 1979, from a range 1.2 million kilometers (750,000 miles). Most of this portion of Ganymede will be imaged at high resolution during closest approach with the satellite on the evening of July 8, 1979. The photo shows a large dark circular feature about 3,200 kilometers (2,000 miles) in diameter, with narrow, closely spaced light bands traversing its surface. The bright spots dotting the surface are relatively recent impact craters, while lighter circular areas may be older impact areas. The light branching bands are ridged and grooved terrain first seen on Voyager 1, and are younger than the more heavily cratered dark regions. The nature of the brighter region covering the southern part of the dark circular feature is uncertain, but it may be some type of condensate. Most of the features seen on the surface of Ganymede are probably both internal and external responses of the very thick icy layer which comprises the crust of this satellite.

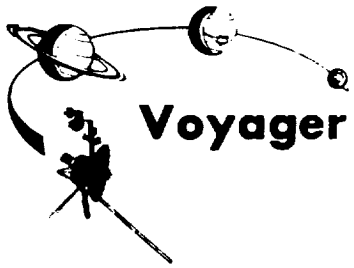




HQ # 79-H-387

Two close-up photos of Ganymede, largest of Jupiter's 13 moons, were obtained on July 8 by Voyager 2 from 140,000 kilometers (86,000 miles) (top) and 310,000 kilometers (192,000 miles). They show different views of the largest block of dark, heavily cratered terrain seen on the giant moon. The bottom image shows objects five or six kilometers (three to four miles) across, and has a resolution of about 2.4 kilometers (1.5 miles). The light, linear stripes recurring across the dark region resemble the outer rings of the large ring structure on Callisto. If these features are in fact related to an ancient ring structure formed by a large impact, their small curvature suggests that the original structure was even larger than the one seen on Callisto. There is no apparent trace now of the center of this suggested structure, which must have been destroyed by the resurfacing evident over most of Ganymede in the grooved terrain. Another interpretation is that these features are not impact-related rings, but are internally produced fractures crossing the dark terrain, similar to the grooved bands.





HQ # 79-H-388

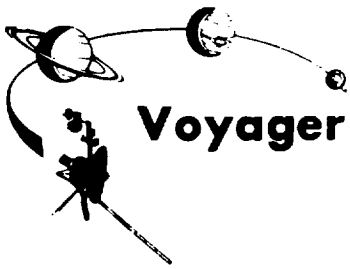
Right: This picture shows part of the surface of Ganymede as viewed from a range of 120,000 kilometers (74,000 miles) by Voyager 2 on July 9. In the foreground is typical grooved terrain as seen by Voyager 1. It consists of mutually intersecting bands of closely spaced, parallel ridges and grooves. In the background is newly cratered dark terrain, across which can be traced several widely spaced parallel linear features. When viewed from a distance, the line features appear to trace broad circular areas. The features resemble the circular ridges on Callisto that surround an almost completely annealed impact basin. The feature on Ganymede may be of similar origin, but all traces of the impact itself have been destroyed.

Left: This picture of Ganymede was taken at a range of 169,000 kilometers (105,000 miles) by Voyager 2 on July 9. Dark contrast terrain is separated by bright bands of grooved terrain. The band of closely spaced linear grooves in the foreground is 150 kilometers (93 miles) across and appears to be offset by another narrow band at right angles, as though by faulting. A variety of ray patterns are seen around craters. One is at the left of the picture, with prominent dark rays around an inner bright halo. Other craters have dark halos; still others have diffuse bright rays. The variation in albedo patterns around the craters may be an indication of layering in the surface materials. The intensity of craters suggests the dark areas are extremely old. The bright, grooved terrain is less cratered and probably somewhat younger.

Voyager

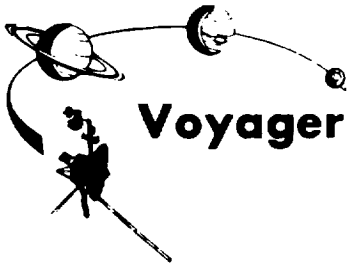
HQ # 79-H-393
79-HC-283
JPL # P-21761 B/W

This color reconstruction of part of the northern hemisphere of Ganymede was made from pictures taken at a range of 313,000 kilometers (194,000 miles). The scene is approximately 1,300 kilometers (806 miles) across. It shows part of a dark, densely cratered block which is bounded on the south by lighter and less cratered, grooved terrain. The dark blocks are believed to be the oldest parts of Ganymede's surface. Numerous craters are visible, many with central peaks. The large, bright, circular features have little relief and are probably the remnants of old, large craters that have been annealed by flow of the icy near-surface material. The closely spaced, arcuate, linear features are probably analogous to similar features on Ganymede which surround a large impact basin. The linear features here may indicate the former presence of a large impact basin to the southwest.



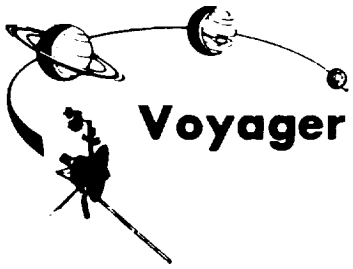
HQ # 79-HC-284
79-H-394

This color picture of Ganymede in the region 30 degrees S 180 degrees W shows features as small as six kilometers (3.7 miles) across. At bottom is a bright halo impact crater that shows the fresh material thrown out of the crater. In the background is bright, grooved terrain that may be the result of shearing of the surface materials along the fault planes. The dark background material is the ancient, heavily cratered terrain—the oldest material preserved on the Ganymede surface.



HQ # 79-HC-287
79-H-400

Voyager 2 took this picture of Ganymede as the spacecraft was nearing its encounter with the icy giant. It was taken from a range of 312,000 kilometers (195,000 miles), and its shows features down to about five or six kilometers (3 to 4 miles) across. Clear examples of several of the different types of terrain common on Ganymede's surface are visible. The boundary of the largest region of dark, ancient terrain on Ganymede can be seen to the east (right), revealing some of the light, linear features which may be all that remains of a large ancient impact structure similar to the large ring structure on Callisto. The broad, light regions running through the image are the typical grooved structures seen within most of the light regions on Ganymede. To the lower left is another example of what might be evidence of large-scale lateral motion in Ganymede's crust. The band of grooved terrain (about 100 kilometers, or 60 miles, wide) in this region appears to be offset by 50 kilometers or more (at least 30 miles) on the left-hand edge by a linear feature discovered by Voyager 1. These are the first clear examples of strike-slip style faulting on any planet other than Earth. Many examples of craters of all ages can be seen in this image, ranging from fresh, bright ray craters to large, subdued circular markings thought to be the "scars" of large, ancient impacts that have been flattened by glacier-like flows.



HQ # 79-H-502

This photomosaic of Ganymede, Jupiter's largest satellite, was taken on the morning of July 9, 1979, by Voyager 2 at a range of about 100,000 kilometers (62,000 miles). It shows numerous impact craters, many with bright ray systems. The rough mountainous terrain at lower right is the outer portion of a large, fresh impact basin which post-dates most of the other terrain. At bottom, portions of grooved terrain transect other portions, indicating that they are younger. This may be the result of the intrusion of new icy material which comprises the crust of Ganymede. The dark patches of heavily cratered terrain (right center) are probably ancient icy material formed prior to the grooved terrain. The large, rayed crater at upper center is about 150 kilometers (93 miles) in diameter.

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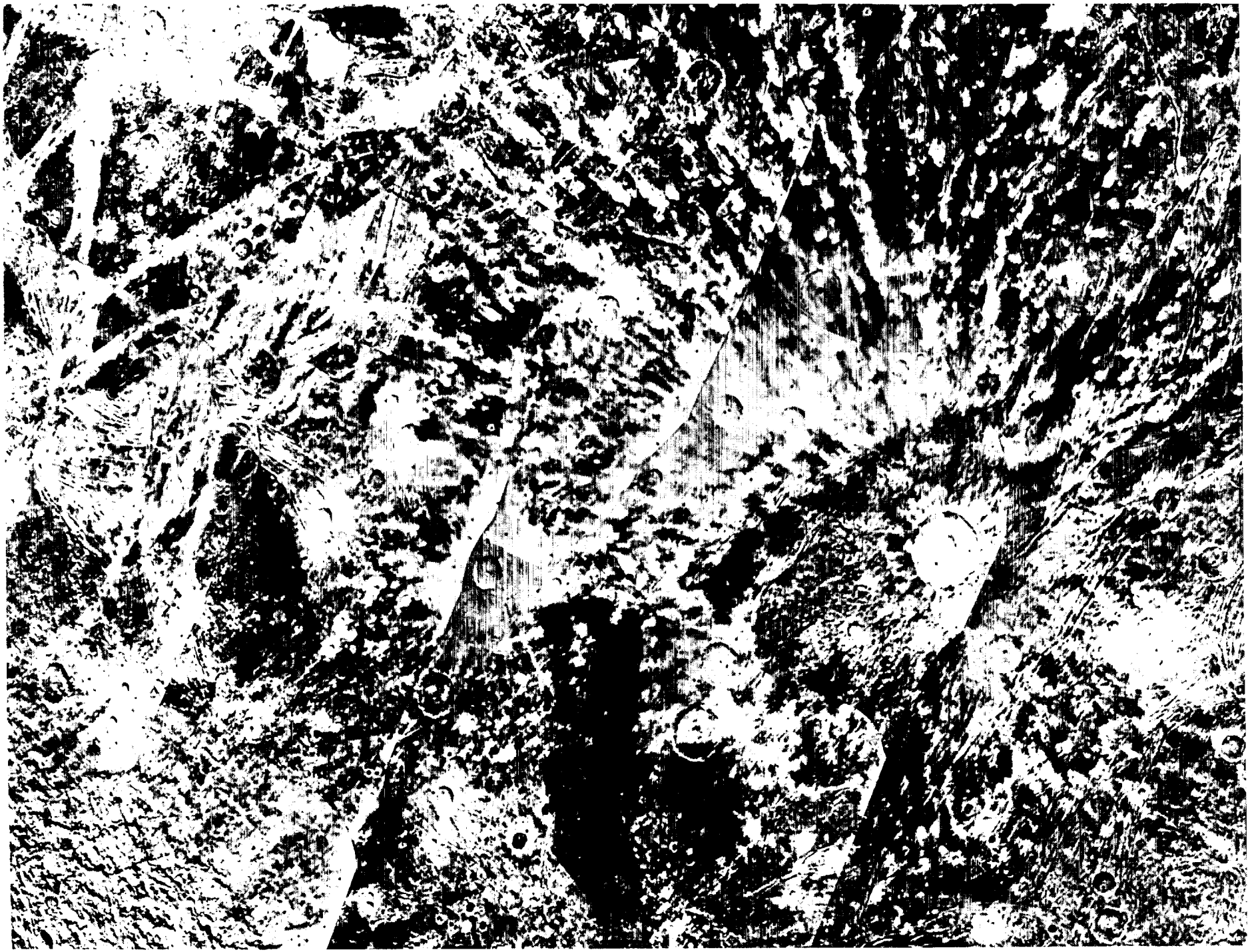

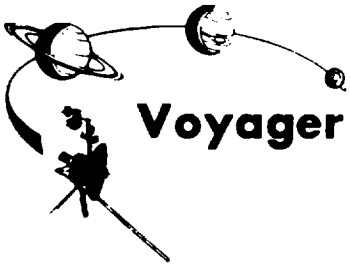

HQ # 79-H-506

Ancient, cratered terrain on Jupiter's giant satellite Ganymede is portrayed here from a distance of 85,000 kilometers (53,000 miles). The picture was taken late on July 8 by Voyager 2 as it approached Jupiter. A large variety of impact craters of different ages are shown. The brightest craters are the youngest. The ejecta blankets fade with age. In the center is a bright patch that represents the rebounding of the floor of the crater. The dirty ice has lost all topography except for faint circular patterns. Also shown are the "Callisto type" curved troughs and ridges that mark an ancient enormous impact basin. The basin itself has been destroyed by later geologic processes. Only the ring features are preserved on the ancient surface. Near the bottom of the picture, these curved features are truncated by the younger terrain.

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